User's
Manual

DL850/DL850V
ScopeCorder
Real Time Math (/G3 option)

YOKOGAWA
Yokogawa Meters & Instruments Corporation

IM DL850-51EN
4th Edition

Thank you for purchasing this DL850/DL850V with the real time math (/G3) option. This user's manual explains the real time math feature.

Manual Title	Manual No.	Description
DL850/DL850V ScopeCorder Real Time Math (/G3 option) User's Manual	IM DL850-51EN	This manual. The supplied CD contains the PDF file of this manual. The manual explains the real time math feature.

For information on other features, how to use these features, and handling precautions, see the following manuals.

Manual Title	Manual No.	Description
DL850/DL850V ScopeCorder Features Guide	IM DL850-01EN	The supplied CD contains the PDF file of this manual. This manual explains all the DL850/DL850V features other than the communication interface features.
DL850/DL850V ScopeCorder User's Manual	IM DL850-02EN	The supplied CD contains the PDF file of this manual. The manual explains how to operate the DL850/DL850V.
DL850/DL850V ScopeCorder Getting Started Guide	IM DL850-03EN	This manual explains the handling precautions and basic operations of the DL850/DL850V.
DL850/DL850V ScopeCorder Communication Interface User's Manual	IM DL850-17EN	The supplied CD contains the PDF file of this manual. This manual explains the DL850/DL850V communication interface features and how to use them.

Notes

- This manual covers firmware versions 1.35 and later of the DL850/DL850V.
- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functionality. The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
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Revisions

- 1st Edition: March 2011
- 2nd Edition: July 2011
- 3rd Edition: February 2012
- 4th Edition: July 2012

4th Edition: July 2012 (YMI)
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Conventions Used in This Manual

Notes and Cautions

The notes and cautions in this manual are categorized using the following symbols.

Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

CAUTION Calls attention to actions or conditions that could cause light injury to the user or cause damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

Note Calls attention to information that is important for proper operation of the instrument.

Unit

k	Denotes 1000. Example: 100 kS/s (sample rate)
K	Denotes 1024. Example: 720 KB (file size)

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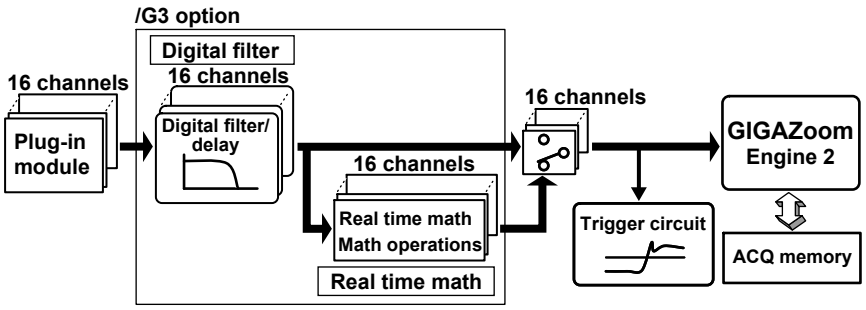
1 Features

The digital filter, delay, and real time math features can be used on DL850/DL850Vs with the /G3 option.

- You can set a digital filter or delay on input channel waveforms (A/D converted data). You can also perform real time math operations in which the waveforms of input channels or the results of other real time math operations are used as the math source waveforms.
- The results of filtering and math operations are acquired in acquisition memory—the same place that input channel waveforms are acquired.
- You can perform filtering and math operations on up to 16 channels at the same time.
- By setting the waveform that results from filtering or math operations as a trigger source, you can trigger the DL850/DL850V on the results.



Digital Filter and Delay (Filter/Delay Setup)

You can set digital filters and delays on input channel waveforms (A/D converted data). This is one of the features of the /G3 option.

- Configure the settings for each channel. You can perform filtering on up to 16 channels at the same time.
- Even during waveform acquisition, you can set the filter type, filter band, and cutoff frequency.
- The digital filter/delay setup menu is displayed when the real time math menu is turned off.
- To enable the digital filter/delay feature and the real time math feature at the same time, you have to first configure the digital filter/delay settings, and then turn the real time math menu on.
- You cannot set digital filters or delays on the bits or input channels of a logic, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, or CAN & LIN bus monitor module.
- By setting the waveform that results from filtering as a trigger source, you can trigger the DL850/DL850V on the results.
- For details on the digital filter characteristics, delay, and settings, see the appendix.

Bandwidth (Bandwidth)

When you set a filtering feature, it takes effect immediately.

- Digital (Digital): Select this item to display a menu for configuring the optional digital filter.
- LPF: Select this item to display a menu for configuring the standard filter.
  For details on the standard filter feature, see the *Features Guide*, IM DL850-01EN.

Filter Type (Filter Type)

The following digital filter types are available: Gauss, Sharp, IIR, and Mean. The features of each filter are listed below.

Filter Type	Features	Operation Type
Gauss	• Frequency characteristics with a smooth attenuation slope • Linear phase and constant group delay • No ripples present in the passband • No overshoot in the step response • Low order and short delay	FIR
Sharp	• Frequency characteristics with a sharp attenuation slope (–40 dB at 1 oct) • Linear phase and constant group delay • Ripples present in the passband • Comb-shaped stopband	FIR
IIR	• Attenuation slope steepness between those of the SHARP and GAUSS filters • Non-linear phase and non-constant group delay • No ripples present in the passband and stopband • Characteristics similar to those of analog filters • Compared to Sharp and Gauss filters, lower cutoff frequency possible	IIR
Mean	• Comb-shaped frequency characteristics • Linear phase and constant group delay • No overshoot in the step response	FIR

Filter Band (Filter Band)

When the filter type is set to Gauss, Sharp, or IIR, you can select the filter band. The type of filter band that you can select depends on the filter type.

Filter Type	Filter Band
Gauss	Low-Pass
Sharp	Low-Pass, High-Pass, Band-Pass
IIR	Low-Pass, High-Pass, Band-Pass

Cutoff Frequency (CutOff)

When the filter type is set to Sharp, Gauss, or IIR and the filter band is set to Low-Pass or High-Pass, you can set the cutoff frequency. The ranges and resolutions are indicated below.

Filter Type	Filter Band	Range	Resolution
Gauss	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.0002 kHz (0.002 kHz to 0.0298 kHz range)
			0.002 kHz (0.03 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
Sharp	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.0002 kHz (0.002 kHz to 0.0298 kHz range)
			0.002 kHz (0.03 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
	High-Pass	0.20 kHz to 300 kHz Default value: 300 kHz	0.02 kHz (0.20 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
IIR	Low-Pass	0.002 kHz to 300 kHz Default value: 300 kHz	0.002 kHz (0.002 kHz to 0.298 kHz range)
			0.02 kHz (0.30 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)
	High-Pass	0.02 kHz to 300 kHz Default value: 300 kHz	0.02 kHz (0.02 kHz to 2.98 kHz range)
			0.2 kHz (3.0 kHz to 29.8 kHz range)
			2 kHz (30 kHz to 300 kHz range)

Center Frequency (Center Frequency)

When the filter type is set to Sharp or IIR and the filter band is set to Band-Pass, set the center frequency. The ranges and resolutions are indicated below.

Filter Type	Range	Resolution
Sharp	0.30 kHz to 300 kHz Default value: 300 Hz	0.02 kHz (0.30 kHz to 2.98 kHz range)
		0.2 kHz (3 kHz to 29.8 kHz range)
		2 kHz (30 kHz to 300 kHz range)
IIR	0.06 kHz to 300 kHz Default value: 300 Hz	0.02 kHz (60 Hz to 1.18 kHz range)
		0.2 kHz (1.2 kHz to 11.8 kHz range)
		2 kHz (12 kHz to 300 kHz range)

Bandwidth (Pass Band)

When the filter type is set to Sharp or IIR and the filter band is set to Band-Pass, set the bandwidth. The bandwidth options vary depending on the center frequency that you have set. For details about these options, see the appendix.

Tap (Tap)

When the filter type is set to Mean, select the number of taps (number of levels) from the following options. The larger the number of taps, the sharper the filter characteristics become.

2, 4, 8, 16, 32, 64, 128

Mean Sample Rate (Mean Sample)

When the filter type is set to Mean, select the sample rate from the following options. The specified sample rate is used to sample waveforms and to filter them.

1 M, 100 k, 10 k, 1 k (unit: S/s)

Interpolation On and Off (Interpolate)

Select whether to perform data interpolation. Up to 10 M samples of data can be interpolated from the data of waveforms that pass through the digital filter. The interpolation method is linear interpolation.

- ON: Data is interpolated.
- OFF: Data is not interpolated.

Delay (Delay)

You can set a delay on waveforms that pass through the digital filter.

The sampling data is decimated in a simple manner to produce the data delay. Consequently, if you set a large delay, data updating automatically becomes slower. The default value is 0.0 µs.

Range	Resolution	Data Update Frequency
0.0 µs to 100 µs	0.1 µs	10 MHz
101 µs to 1.00 ms	1 µs	1 MHz
1.01 ms to 10.00 ms	0.01 ms	100 kHz

Note

The delay is valid even if you are not using the digital filter. However, if you set a delay, the sampling data automatically passes through the digital filter circuit. Therefore, the actual delay when you are not using the digital filter is 1.4 µs (the minimum math delay) + the set delay.

Real Time Math (RealTime Math)

Turning Real Time Math On and Off

Select whether to use real time math.

- ON: Select this item to display a menu for configuring real time math. At the same time, real time math execution begins.
- OFF: Select this item to display a menu for configuring the standard model. Real time math is not executed.
  For details on the features of the standard model, see the *Features Guide*, IM DL850-01EN.

You can perform real time math operations in which the waveforms of input channels or the results of other real time math operations are used as the math source waveforms. This is one of the features of the /G3 option.

- Configure the settings for each channel. You can perform math operations on up to 16 channels at the same time.
- When you turn real time math on, the real time math results are output to the real time math channels (the channels that you have turned math on for). The waveforms of input channels that you have turned math on for are not displayed. They are also not saved. For example, if you turn real time math on for input channel CH2, CH2 becomes the RMath2 real time math channel, and the math results are displayed on the screen. The data that is saved is that of the math result. If you want to display and save the waveform of the input channel, set the real time math to a channel that has no input.
- You can set the real time math source waveforms to the input channels of 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, and CAN & LIN bus monitor module, but you cannot set the channel that the real time math result is output on to an input channel of a 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, or CAN & LIN bus monitor module (there is no menu for turning real time math on).
- For details on the modules whose channels you can set as real time math sources, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.
- Even during waveform acquisition, you can set various math conditions, such as the operator or function (the operation definition), the source waveforms, and the coefficients. However, if you change the conditions, the measurement count (waveform acquisition count) is reset. The measurement count is displayed in the lower left of the screen. In roll mode during waveform acquisition, real time math cannot be turned on and off.
- By setting the waveform that results from math operations as a trigger source, you can trigger the DL850/DL850V on the results.
- For details on the math expressions, delay, and settings, see the appendix.

Labels (Label)

This is the same as the feature on the standard model. For details, see the *Features Guide*, IM DL850-01EN.

Real Time Math Setup (RealTime Math Setup)

Select an operator or function (operation definition), and then set its corresponding items.

Operators and Functions (Operation)

- S1+S2: Adds the waveforms assigned to Source1 and Source2
- S1–S2: Subtracts the waveform assigned to Source2 from the waveform assigned to Source1
- S1*S2: Multiplies the waveforms assigned to Source1 and Source2
- S1/S2: Divides the waveform assigned to Source1 by the waveform assigned to Source2
- A(S1)+B(S2)+C: Performs addition with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)–B(S2)+C: Performs subtraction with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)*B(S2)+C: Performs multiplication with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)/B(S2)+C: Performs division with coefficients on the waveforms assigned to Source1 and Source2

- Diff(S1): Performs differentiation on the waveform assigned to Source using a fifth order Lagrange interpolation formula
- Integ1(S1): Performs integration on the positive component of the waveform assigned to Source
- Integ2(S1): Performs integration on the positive and negative components of the waveform assigned to Source
- Rotary Angle: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to calculate the angle of rotation. This can be used to calculate the angle of rotation or the displacement of an encoder.
- DA: Converts the logic signals that have been assigned to Source1 (the least significant digits) and Source2 (the most significant digits) into an analog waveform and scales the results
- Polynomial: Performs a quartic polynomial calculation on the waveform that has been assigned to Source
- RMS: Calculates the RMS value of the waveform that has been assigned to Source
- Power: Calculates the effective power of the waveforms that have been assigned to Source1 and Source2
- Power Integ: Integrates the effective power of the waveforms that have been assigned to Source1 and Source2.
- Log1: Calculates the common logarithm of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”)
- Log2: Calculates the common logarithm of the waveform that has been assigned to Source
- Sqrt1: Calculates the square root of the sum (or difference) of the squares of the waveforms that have been assigned to Source1 and Source2. This can be used to analyze displacement and tolerance.
- Sqrt2: Calculates the square root of the waveform that has been assigned to Source
- Cos: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the cosine of this angle. You can use this to convert the angle to displacement.
- Sin: Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the sine of this angle. You can use this to convert the angle to displacement.
- Atan: Calculates the arc tangent of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”). You can use this to convert the displacement to an angle.
- Electrical Angle: Calculates the phase difference between (1) the angle that was determined from the logic signals that were specified for phases A, B, and Z, and (2) the fundamental component that was determined from the discrete Fourier transform of the waveform that was specified as the target. You can calculate the phase difference (electrical angle) between the motor’s angle of rotation and the motor drive current.
- Knock Filter (can only be set on the DL850V): When the signal level of the waveform that has been set to Source is less than or equal to the elimination level, the signal of this waveform is set to 0. You can select whether to perform differentiation. You can use this to extract knocking.
- Poly-Add-Sub: Performs addition or subtraction or both on the waveforms that have been set to Source1, Source2, Source3, and Source4. You can add or subtract the result of the power calculation, to calculate the multi-phase power.
- Frequency: Calculates the frequency of the waveform that has been assigned to Source
- Period: Calculates the period of the waveform that has been assigned to Source
- Edge Count: Counts the number of slope edges of the waveform that has been assigned to Source. You can use this to count the number of events in consecutive tests.

- Resolver: Calculates the angle of rotation from the sine signal and cosine signal that are generated from the detection coils of the resolver depending on the angle of the rotor.
- IIR Filter: This can be used to filter the waveform that has been set to Source with the same characteristics of the IIR filter of the digital filter. You can set the frequency to values over a wider range than is available with the IIR filter of a digital filter.
- PWM: Integrates a pulse width modulation signal and demodulates it to an analog signal.
- Reactive Power(Q): Calculates the reactive power from apparent power and effective power.
- CAN ID: Detects the frame of the CAN bus signal with the specified ID.

* Resolver, IIR filter, and PWM can be used on models with firmware version 2.00 and later. Reactive Power(Q) and CAN ID can be used on models with firmware version 2.05 and later.

Turning the Mean On and Off (Mean)

Select whether to perform the mean. This mean is the same feature as the one in the digital filter. However, the number of taps is fixed to 32. The sampling frequency is the same as the DL850/DL850V sample rate. The maximum sampling frequency is 10 MHz.

- ON: The mean is performed.
- OFF: The mean is not performed.

Optimizing Value/Div (Optimize Value/Div)

Press the Optimize Value/Div soft key to automatically set the value/div that the DL850/DL850V determines is the most appropriate for the math source waveform range and the expression. The selected value is from among the 123 value/div options for vertical axis sensitivity.

- The automatically selected option does not line up with the input values and math results, so you need to use the SCALE knob to change the value/div.
- There are a total of 123 value/div options within the following range: 500.0E+18 to 10.00E–21 (in steps of 1, 2, or 5).

Waveform Vertical Position (Vertical POSITION knob)

This is the same as the feature on the standard model. For details, see the *Features Guide*, IM DL850-01EN.

Zoom Method (V Scale), Zooming by Setting a Magnification (V Zoom), Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

This is the same as the feature on the standard model. For details, see the *Features Guide*, IM DL850-01EN.

Offset (Offset)

This is the same as the feature on the standard model. For details, see the *Features Guide*, IM DL850-01EN.

Trace Settings (Trace Setup)

This is the same as the feature on the standard model. For details, see the *Features Guide*, IM DL850-01EN.

Unit (Unit)

You can assign a unit of up to four characters in length to the math results. The specified unit is reflected in the scale values.

All Channels Setup Menu

There is a menu (ALL CH) that is used to configure the settings for all channels for real time math. The menu is operated in the same way as the all channels setup menu on the standard model.

- You can configure the real time math settings of all channels while viewing the settings in a list.
- You can turn real time math on and off for all channels at once.
- There are some items that cannot be configured from the ALL CH menu.

Basic Arithmetic (S1+S2, S1–S2, S1*S2, and S1/S2)

Performs addition, subtraction, multiplication, or division on the two waveforms assigned to Source1 and Source2.

Math Source Waveforms (Source1 and Source2)

CH1 to CH16,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] RMath1 to RMath15[4]

1 You can select input channels of installed modules. However, you cannot select input channels of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On the DL850V when a CAN bus monitor module or CAN & LIN bus monitor module is installed. After you select CAN or LIN, select a sub channel. You cannot select waveforms whose data type (Value Type) is set to Logic. Even if the data type is not set to Logic, you cannot use data that exceeds 16 bits in length.
4 You can use other RMath waveforms as math source waveforms. If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX–1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.

Basic Arithmetic with Coefficients (A(S1)+B(S2)+C, A(S1)–B(S2)+C, A(S1)*B(S2)+C, A(S1)/B(S2)+C)

Performs addition, subtraction, multiplication, or division with coefficients on the two waveforms assigned to Source1 and Source2.

Math Source Waveforms (Source1 and Source2)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Coefficients (A, B, and C)

Set the scaling coefficients (A and B) and the offset (C).
Range: –9.9999E+30 to +9.9999E+30
Default value of A and B: 1.0000
Default value of C: 0.0000

Differentiation (Diff(S1))

Performs differentiation on the waveform assigned to Source using a fifth order Lagrange interpolation formula. For details on the differentiation characteristics, see the appendix.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Integration (Integ1(S1) and Integ2(S1))

Integration is performed on the waveform that has been assigned to Source.

- Integ1(S1): Performs integration on the positive component of the waveform assigned to Source
- Integ2(S1): Performs integration on the positive and negative components of the waveform assigned to Source

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Reset Condition (Reset Condition)

Select the condition for resetting integration from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below –10 div
- Zero crossing (ZeroCross): When the math source waveform signal crosses zero
  Set the slope direction (positive or negative) and the hysteresis when the signal crosses zero. The hysteresis level is the same as the trigger hysteresis. For details, see the *Features Guide*, IM DL850-01EN.

Manual Reset (Manual Reset)

To manually reset the integration, select Execute.

Angle of Rotation (Rotary Angle)

Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to calculate the angle of rotation. This can be used to calculate the angle of rotation or the displacement of an encoder.

Type (Type)

You can select the type of the encoding from the following options.

- Incremental ABZ (Incremental ABZ): The angle of rotation is calculated from the A, B, and Z phase signals.
- Incremental AZ (Incremental AZ): The angle of rotation is calculated from the A and Z phase signals.
- Absolute 8 bit (Absolute 8bit): The angle of rotation is calculated from an 8-bit logic signal (binary code).
- Absolute 16 bit (Absolute 8bit): The angle of rotation is calculated from a 16-bit logic signal (binary code).
- Gray code (Gray Code): The angle of rotation is calculated from a logic signal (gray code) consisting of 2 to 16 bits.

Source Conditions (Source Condition)

Set the conditions of the source whose pulses you want to count.

If the type of the encoding is ABZ or AZ

- **Turning the logic source on and off (Logic Source)**
  - ON: You can set the A, B, and Z phase signals to the signals of logic modules.
  - OFF: You can set the A, B, and Z phase signals to the signals of analog waveform modules. The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules or real time math channels (RMath). For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.
- **When logic sources are turned on**
  - Source (Source): Select an input channel of a logic module.
  - Phase A (Phase A): Select the bit that you want to use for the phase A signal from among the logic signals of the selected input channel.
  - Phase B (Phase B): Select the bit that you want to use for the phase B signal from among the logic signals of the selected input channel.
  - Phase Z (Phase Z): Select the bit that you want to use for the phase Z signal from among the logic signals of the selected input channel.

- **When logic sources are turned off**

  Set the input channels for the phase A, B, and Z signals,[1] the signal level of each signal that you will count as a pulse,[2] and the hysteresis of each signal.[3]
  - Phase A (Phase A): Set the input channel, signal level, and hysteresis of the phase A signal.
  - Phase B (Phase B): Set the input channel, signal level, and hysteresis of the phase B signal.
  - Phase Z (Phase Z): Set the input channel, signal level, and hysteresis of the phase Z signal.

  To set the timing that pulses are counted and the timing that the pulse count is reset for the signal level that you set here, see “Encoding Conditions” later in this section.

  1 The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules or real time math channels (RMath). For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.
  2 The signal level range is the same as the trigger level range. For details, see the *Features Guide*, IM DL850-01EN.
  3 The hysteresis level is the same as the trigger hysteresis. For details, see the features guide, IM DL850-01EN.

If the type of the encoding is absolute 8 bit, absolute 16 bit, or gray code

Select the input channel of the logic module. For absolute 16 bit and gray code encoding, set the logic channel for the least significant digits to Source1 and the logic channel for the most significant digits to Source2.

* When the bit length of Gray Code is 8 or less, the Source2 setting is ignored.

Pulses per Rotation (Pulse/Rotate)

Set the number of pulses per rotation.

Range: 1 to 65535. The default value is 180.

Bit Length (Bit Length)

When the bit length (Bit Length) encoding type is set to Gray Code, set the bit length.

Selectable range: 2 to 16

Scaling (Scaling)

Select the unit that is used on the vertical scale.

- Radian: Radian
- Degree: Degrees
- User-defined (User Define): Set K, the size of the scale.

  Range: –9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Encoding Conditions (Encode Condition)

If the type of the encoding is ABZ or AZ, set the encoder’s pulse multiplier and the timing (edge) for counting pulses.

Count Conditions (Count Condition)

You can select the encoder’s pulse multiplier from the following options.

×4, ×2, ×1

When the multiplier is ×4, regardless of the timing setting made in the next section, pulses are counted on all the edges of the signal.

Timing1 (Timing1)

Select the edges that are counted as pulses when the multiplier is ×1.

- A ⤴: Rising edge of the phase A signal
- A ⤵: Falling edge of the phase A signal
- B ⤴: Rising edge of the phase B signal
- B ⤵: Falling edge of the phase B signal

Rising edge: The point where the signal rises from a low level and passes through the specified signal level

Falling edge: The point where the signal falls from a high level and passes through the specified signal level

If the signal is that of an analog waveform, turn the logic sources off as shown earlier this manual in "Source Conditions," and then set the signal level that is counted as a pulse and the hysteresis.

Timing2 (Timing2)

Select the edges that are counted as pulses when the multiplier is ×2.

The options are the same as were described above for Timing1.

When the multiplier is ×2, if you select the same edges as in Timing1, the pulse count conditions are the same as were explained for multiplier ×1.

Reset Timing (Reset Timing)

Select the timing (edge) at which the pulse count will be reset.

- A ⤴: Rising edge of the phase A signal
- A ⤵: Falling edge of the phase A signal
- B ⤴: Rising edge of the phase B signal
- B ⤵: Falling edge of the phase B signal
- Z level (Z Level): When the Z phase signal is at a high level.

Reverse (Reverse)

Set the direction that the angle of rotation increases in.

- ON: The rotation is counter-clockwise.
- OFF: The rotation is clockwise.

Manual Reset (Manual Reset)

To manually reset the angle of rotation, select Execute.

Logic Signal to Analog Waveform Conversion (DA)

Converts the logic signals that have been assigned to Source1 (the least significant digits) and Source2 (the most significant digits) into an analog waveform and scales the results.

Math Source Waveforms (Source1 and Source2)

You can select input channels of an installed logic module. Set the logic channel for the least significant digits to Source1 and the logic channel for the most significant digits to Source2. You cannot select the input channels of CAN bus monitor modules or CAN & LIN bus monitor modules.

Type (Type)

Select the type of the logic signal.

- Unsigned: Unsigned integer
- Signed: Signed integer
- Offset Binary: Offset binary

Bit Length (Bit Length)

Set the bit length that will be converted to an analog signal. The length that you specify will be counted from the least significant bit.
Range: 2 to 16. The default value is 16.

Coefficient (K)

Set scaling coefficient K.
Range: –9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Quartic Polynomial (Polynomial)

Performs a quartic polynomial calculation on the waveform that has been assigned to Source.

$As^4+Bs^3+Cs^2+Ds+E$

A, B, C, and D: Scaling coefficients
s: Sampling data
E: Offset

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Coefficients (A, B, C, D, and E)

Set the scaling coefficients (A, B, C, and D) and the offset (E).
Range: –9.9999E+30 to +9.9999E+30
Default value of A and B: 1.0000
Default value of C, D, and E: 0.0000

RMS Value (RMS)

Calculates the RMS value of the waveform that has been assigned to Source.

$$\sqrt{\frac{1}{N}\sum_{n=1}^{N} s(n)^2}$$

s: Sampling data
N: Number of samples

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Calculation Period (Calc Period)

Select the method that is used to determine the RMS calculation period.

- Edge: Rising or falling edge of the selected signal or both edges
- Time: Specified time

If the Calculation Period Is Edge

- **Edge detection source (Edge Source)**
  Select the input channel of the signal that is used to determine the calculation period.
  If you want to use the same channel as the math source waveform, select Own. You can also select other channels. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.
- **Level (Level), Slope (Slope), and Hysteresis (Hysteresis)**
  Set the signal level,[1] the slope (rising or falling), and the hysteresis[2] of the edges that separate the calculation periods.
  1 The signal level range is the same as the trigger level range. For details, see the *Features Guide*, IM DL850-01EN.
  2 The hysteresis level is the same as the trigger hysteresis. For details, see the *Features Guide*, IM DL850-01EN.

If the Calculation Period Is Time

Time (Time)

Set the calculation period time.
Range: 1 ms to 500 ms. Default value: 1 ms. Resolution: 1 ms.

Effective Power (Power)

Calculates the effective power of the waveforms that have been assigned to Source1 and Source2.

$$\frac{1}{T}\int_{0}^{T} (s1 \cdot s2)dt$$

T: 1 period (calculation period)
s1 and s2: Sampling data
dt: Sampling period

Math Source Waveforms (Source1 and Source2)

Set the voltage and current input channels to use to calculate the effective power to Source1 and Source2. The options are the same as were described above for basic arithmetic. However, you cannot select input channels of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Calculation Period (Calc Period)

Set the calculation period for the effective power calculation.

Edge Detection Source (Edge Source)

Select the input channel of the signal that is used to determine the calculation period.
If you want to use the same channel as the math source waveform, select Source1 or Source2. You can also select other channels. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Level (Level), Slope (Slope), and Hysteresis (Hysteresis)

Set the signal level, the slope, and the hysteresis of the edges that separate the calculation periods. These settings are shared with the RMS operation.

Effective Power Integration (Power Integ)

Integrates the effective power of the waveforms that have been assigned to Source1 and Source2.

$$\int_0^T (s1 \cdot s2)dt$$

T: Integration time
s1 and s2: Sampling data
dt: Sampling period

Math Source Waveforms (Source1 and Source2)

Set the voltage and current input channels to use to integrate the effective power to Source1 and Source2. The options are the same as were described above for basic arithmetic. However, you cannot select input channels of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Reset Condition (Reset Condition)

Select the condition for resetting integration from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below –10 div

Manual Reset (Manual Reset)

To manually reset the integration, select Execute.

Scaling (Scaling)

Select the unit that is used on the vertical scale.

- Seconds (Second): The unit is seconds.
- Hours (Hour): The unit is hours.

Common Logarithm (Log1 and Log2)

- Log1:Calculates the common logarithm of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”).
  $K \cdot \log_{10}(s1/s2)$ K: Coefficient. s1 and s2: Sampling data.
- Log2:Calculates the common logarithm of the waveform that has been assigned to Source.
  $K \cdot \log_{10}(s)$ K: Coefficient. s: Sampling data.

Math Source Waveforms (Source1, Source2, and Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Coefficient (K)

Set scaling coefficient K.
Range: –9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Square Root (Sqrt1 and Sqrt2)

- Sqrt1: Calculates the square root of the sum (or difference) of the squares of the waveforms that have been assigned to Source1 and Source2. This can be used to analyze displacement and tolerance.

  $\sqrt{s1^2 \pm s2^2}$ s1 and s2: Sampling data

- Sqrt2: Calculates the square root of the waveform that has been assigned to Source

  $\sqrt{s}$ s: Sampling data

Math Source Waveforms (Source1, Source2, and Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Sign (Sign)

Set the operator between $s1^2$ and $s2^2$ in Sqrt1.

- +: Addition
- –: Subtraction

Cosine (Cos) and Sine (Sin)

Uses the waveforms or logic signals that have been assigned to phases A, B, and Z to determine the angle, and then calculates the cosine or sine of this angle. You can use this to convert the angle to displacement.

Type (Type)

Select the type of the encoding. The settings other than the Resolver Ch setting are shared with the Rotary Angle operation. You can specify the Resolver Ch setting when there is a channel that has been defined with the resolver function of real time math.

- If there are multiple channels that have been defined with the resolver function, select Resolver Ch, and then select the channel.
- If Resolver Ch has been selected, the setup menu explained later is not displayed.

Source Conditions (Source Condition)

Set the conditions of the source whose pulses you want to count. This setting is shared with the Rotary Angle operation. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Pulses per Rotation (Pulse/Rotate) and Bit Length (Bit Length)

Set the number of pulses per rotation. When the encoding type is set to Gray Code, set the bit length. This setting is shared with the Rotary Angle operation.

Encoding Conditions (Encode Condition)

If the type of the encoding is ABZ or AZ, set the encoder’s pulse multiplier and the timing (edge) for counting pulses. This setting is shared with the Rotary Angle operation.

Manual Reset (Manual Reset)

To manually reset the computed value, select Execute.

Arc Tangent (Atan)

Calculates the arc tangent of the waveforms that have been assigned to Source1 and Source2 (the calculation is performed on “Source1/Source2”). You can use this to convert the displacement to an angle.

atan(s1/s2) s1 and s2: Sampling data

Math Source Waveforms (Source1 and Source2)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Scaling (Scaling)

Select the unit that is used on the vertical scale. This setting is shared with the Rotary Angle operation. However, there are no user-defined settings.

Quadrant Range (Quadrant)

Select the quadrant range to use for converting displacements to angles. This can be used on models with firmware version 2.05 and later.

- Quadrant-2: –90° to +90° (–π/2 to +π/2)
  Even if a calculated result is between –180° and –90° or between +90° and +180°, it is converted to an angle between –90° to +90°.
- Quadrant-4: –180° to +180° (–π to +π)

Electrical Angle (Electrical Angle)

Calculates the phase difference between (1) the angle that was determined from the logic signals that were specified for phases A, B, and Z, and (2) the fundamental component that was determined from the discrete Fourier transform of the waveform that was specified as the target. You can calculate the phase difference (electrical angle) between the motor’s angle of rotation and the motor drive current.

Type (Type)

Select the type of the encoding. The settings other than the Resolver Ch setting are shared with the Rotary Angle operation. You can specify the Resolver Ch setting when there is a channel that has been defined with the resolver function of real time math.

- If there are multiple channels that have been defined with the resolver function, select Resolver Ch, and then select the channel.
- If Resolver Ch has been selected, set the scaling and the target on the setup menus explained later.

Source Conditions (Source Condition)

Set the conditions of the source whose pulses you want to count. This setting is shared with the Rotary Angle operation. However, you can only specify the input channels of logic modules as math source waveforms. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Pulses per Rotation (Pulse/Rotate) and Bit Length (Bit Length)

Set the number of pulses per rotation. When the encoding type is set to Gray Code, set the bit length. This setting is shared with the Rotary Angle operation.

Scaling (Scaling)

Select the unit that is used on the vertical scale. This setting is shared with the Rotary Angle operation. However, there are no user-defined settings.

Encoding Conditions (Encode Condition)

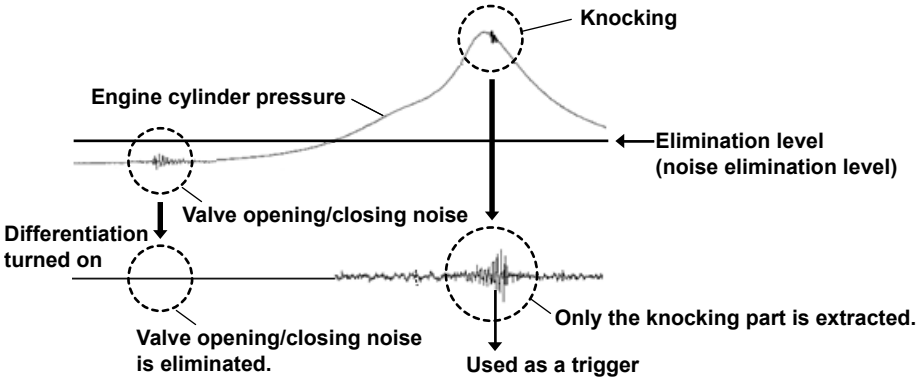
If the type of the encoding is ABZ or AZ, set the encoder’s pulse multiplier and the timing (edge) for counting pulses. This setting is shared with the Rotary Angle operation.

Target (Target)

The fundamental component of the waveform that you specify here is determined through a discrete Fourier transform. If the angle is the motor’s angle of rotation and the target is the motor’s drive current, the electrical angle can be determined.
The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Knocking Filter (Knock Filter; only on the DL850V)

When the signal level of the waveform that has been set to Source is less than or equal to the elimination level, the signal of this waveform is set to 0. You can select whether to perform differentiation. You can use this to extract knocking.



Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you cannot select an input channel of a frequency module or a real time math channel (RMath). For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Elimination Level

Set the elimination level, which is used to set the input signal to 0.
The range of the elimination level is the same as that of the trigger level. For details, see the *Features Guide*, IM DL850-01EN.

Differential

Select whether to differentiate the waveform after elimination. A fifth order Lagrange interpolation formula is used to perform differentiation. For details on the differentiation characteristics, see the appendix.

- ON: Differentiation is performed.
- OFF: Differentiation is not performed.

Polynomial with a coefficient (Poly-Add-Sub)

Performs addition or subtraction or both on the waveforms that have been set to Source1, Source2, Source3, and Source4. You can add or subtract the result of the power calculation, to calculate the multi-phase power.

K (±s1 ±s2 ±s3 ±s4) K: Coefficient. s1, s2, s3, and s4: Sampling data.

Math Source Waveforms (Source1, Source2, Source3, and Source4)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Sign

You can set the sign of the sampling data of the math source waveforms to positive or negative.

Coefficient (K)

Set scaling coefficient K.
Range: –9.9999E+30 to +9.9999E+30. The default value is 1.0000.

Frequency (Frequency)

Calculates the frequency of the waveform that has been assigned to Source.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select an input channel of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Slope (Slope), Level (Level), Hysteresis (Hysteresis)

Set the signal level,[1] the slope (rising or falling), and the hysteresis[2] of the edges that are used to detect the periods. If the math source is the signal of a logic module, only set the slope.

1 The signal level range is the same as the trigger level range. For details, see the *Features Guide*, IM DL850-01EN.

2 The hysteresis level is the same as the trigger hysteresis. For details, see the *Features Guide*, IM DL850-01EN.

Scaling (Scaling)

Select the unit that is used on the vertical scale.

- Hz: The unit is hertz.
- Rpm: The unit is revolutions per minute.

Deceleration Prediction (Deceleration Prediction)

Set whether to compute the decelaration curve from the elapsed time after the pulse input stops.

- ON: Deceleration prediction is performed.
- OFF: Deceleration prediction is not performed. For details, see the features guide, IM DL850-01EN.

Stop Prediction (Stop Prediction)

Set the time from the point when the pulse input stops to the point when the DL850/DL850V determines that the object has stopped.

- 2, 4, 8, 16: Stop prediction is performed on the basis of the specified number of times the pulse period (T) of the pulse one period before the pulse input stopped.
- OFF: Stop prediction is not performed. For details, see the features guide, IM DL850-01EN.

Period (Period)

Calculates the period of the waveform that has been assigned to Source.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select an input channel of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Slope (Slope), Level (Level), Hysteresis (Hysteresis), Deceleration Prediction (Deceleration Prediction), Stop Prediction (Stop Prediction)

Set the slope (rising or falling), signal level, and hysteresis of the edges that are used to detect the periods as well as the deceleration prediction and stop prediction. These settings are shared with the Frequency operation.

Edge Count (Edge Count)

Counts the number of slope edges of the waveform that has been assigned to Source. You can use this to count the number of events in consecutive tests.

Math Source Waveform (Source)

The options are the same as were described above for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select an input channel of a frequency module. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Slope (Slope), Level (Level), Hysteresis (Hysteresis)

Set the slope (rising or falling), the signal level, and the hysteresis of the edges that you want to count. These settings are shared with the Frequency operation.

Reset Condition (Reset Condition)

Select the condition for resetting the count from one of the settings below.

- Start (Start): When the waveform acquisition starts
- Overlimit (Overlimit): When “Value/Div” exceeds +10 div or falls below –10 div

Manual Reset (Manual Reset)

To manually reset the count, select Execute.

Resolver (Resolver)

Calculates the angle of rotation from the sine signal and cosine signal that are generated from the detection coils of the resolver depending on the angle of the rotor. This function can be used on models with firmware version 2.00 and later.

Sine Phase Signal and Cosine Phase Signal (Sin Ch, Cos Ch)

Select the sine signal and the cosine signal that are generated from the detection coil of the resolver. The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Hysteresis (Hysteresis)

Set the rising edge hysteresis of the excitation, sine, and cosine signals. When the sample point mode (which is explained below) is set to Auto, this setting is applied to all signals. When the sample point mode is set to Manual, this setting is applied to the excitation signal.

Sample Point (Sample Point)

Excitation Signal (Carrier Ch)

Select the resolver’s excitation signal. The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Mode (Mode)

To enable more accurate calculations of the angle of rotation, set the mode that is used to sample the peak values of sine and cosine signals.

- Auto: The rising edges of the excitation, sine, and cosine signals are detected, and the peak values of sine signals and cosine signals are sampled automatically.
  - The Auto setting can be applied when the time difference of the sine and cosine signals in reference to the excitation signal is less than ±90°(π/2).
  - Turn the SCALE knob to set the vertical scale (V/div) so that the amplitudes of the excitation, sine, and cosine signals are all ±1.5 div or greater. If the amplitudes are less than ±1.5 div, the Auto function will not operate.
- Manual: The rising edge of the excitation signal is detected, and sine and cosine signals at the specified time (Time) after this detected rising edge are sampled.
  Time Setting
  Selectable range: 0.1 µs to 1000.0 µs, Default value: 0.1 µs, Resolution: 0.1 µs.

Tracking Filter (Tracking Filter)

If the sine signal and cosine signal data is changing in a staircase pattern, select the cutoff frequency of the tracking filter that will smooth out the data that is used to calculate the angle of rotation.
OFF, 2kHz, 1kHz, 250Hz, 100Hz

Scaling (Scaling)

Select how the upper and lower limits of the vertical scale are displayed.
–180Deg to +180Deg, 0Deg to 360Deg, –PI to +PI, 0 to 2PI
* “PI” is displayed as “π” on the screen.

Note

- To improve the calculation accuracy, set the vertical axis sensitivity for each signal so that the signal amplitude is as large as possible.
- Set the vertical axis sensitivity to the same value for sine signals and cosine signals. If you specify different values, the DL850/DL850V cannot perform calculations correctly.

IIR Filter (IIR Filter)

This can be used to filter the waveform that has been set to Source with the same characteristics of the IIR filter of the digital filter. You can set the frequency to values over a wider range than is available with the IIR filter of the digital filter. This function can be used on models with firmware version 2.00 and later.

Math Source Waveforms (Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Filter Band (Filter Band)

Select the filter band.
Low-Pass, High-Pass, Band-Pass

Cutoff Frequency (CutOff)

When the filter band is set to Low-Pass or High-Pass, set the cutoff frequency. The ranges and resolutions are indicated below.

Filter Band	Range	Resolution
Low-Pass	0.2 Hz to 3.00 MHz Default value: 0.30 MHz	0.2 Hz (range: 0.2 Hz to 29.8 Hz)
		2 Hz (range: 30 Hz to 298 Hz)
		0.02 kHz (range: 0.30 kHz to 2.98 kHz)
		0.2 kHz (range: 3.0 kHz to 29.8 kHz)
		2 kHz (range: 30 kHz to 298 kHz)
		0.02 MHz (range: 0.30 MHz to 3.00 MHz)
High-Pass	0.02 kHz to 3.00 MHz Default value: 0.30 MHz	0.02 kHz (range: 0.02 kHz to 2.98 kHz)
		0.2 kHz (range: 3.0 kHz to 29.8 kHz)
		2 kHz (range: 30 kHz to 298 kHz)
		0.02 MHz (range: 0.30 MHz to 3.00 MHz)

Center Frequency (Center Frequency)

When the filter band is set to Band-Pass, set the center frequency. The ranges and resolutions are indicated below.

Range	Resolution
0.06 kHz to 3.00 MHz Default value: 0.30kHz	0.02 kHz (range: 0.06 kHz to 1.18 kHz)
	0.2 kHz (range: 1.2 kHz to 11.8 kHz)
	2 kHz (range: 12 kHz to 118 kHz)
	0.02 MHz (range: 0.12 MHz to 3.00 MHz)

Bandwidth (Pass Band)

When the filter band is set to Band-Pass, select the bandwidth. The bandwidth options vary depending on the center frequency that you have set. For details on the options, see the appendix.

Interpolation On and Off (Interpolate)

Select whether to perform data interpolation. Up to 10 M samples of data can be interpolated from the data of waveforms that pass through the real time math IIR filter. The interpolation method is linear interpolation.

- ON: Data is interpolated.
- OFF: Data is not interpolated.

Demodulation of the Pulse Width Modulated Signal (PWM)

Integrates a pulse width modulation signal and demodulates it to an analog signal. This function can be used on models with firmware version 2.00 and later.

Math Source Waveforms (Source)

The options are the same as were described above for basic arithmetic. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Period of the Pulse Width Modulated Signal (Period)

Set the period of the pulse width modulated signal. The pulse width modulation signal is repeatedly integrated over the set period and demodulated to an analog signal.
Selectable range: 0.1 µs to 5000.0 µs, Default value: 0.1 µs, Resolution: 0.1 µs.

Reactive Power (Reactive Power(Q))

Calculates the reactive power from apparent power and effective power.
To calculate the reactive power, you must use the real time math feature to calculate the apparent power and effective power by following the procedure below. This function can be used on models with firmware version 2.05 and later.

Apparent Power Calculation

1. Calculate the RMS voltage and current (RMS) that are used to derive the reactive power.
2. Take the product of the RMS voltage and current (S1*S2) that were calculated in step 1. The result is the apparent power.

Effective Power Calculation

Calculate the effective power of the RMS voltage and current (Power) that are used to derive the reactive power.

Apparent Power (Apparent Power(S))

Select the real time math channel (RMath channel) used to calculate the apparent power.

Effective Power (Effective Power(P))

Select the real time math channel (RMath channel) used to calculate the effective power.

Reactive Power Polarity

Determine the reactive power polarity from the phases of the voltage and current used to derive the reactive power.

Voltage (Voltage)

Select the voltage channel used to derive the reactive power.
The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

Hysteresis (Hysteresis)

Select the hysteresis used to detect the zero crossing of the selected voltage.
The hysteresis level is the same as the trigger hysteresis. For details, see the *Features Guide*, IM DL850-01EN.

Current (Current)

Select the current channel used to derive the reactive power.
The options are the same as were described above for basic arithmetic. However, you cannot select input channels of frequency modules. For details, see “Notes Regarding Using the Digital Filter and Real Time Math” on page 1-23.

CAN ID Detection (CAN ID)

Detect the frame of the CAN bus signal with the specified ID. A pulse waveform whose detection point is at high level is displayed. This function can be used on DL850V models with firmware version 2.05 and later.

Detection Source Waveforms (Source)

CH1 to CH16,[1] RMath1 to RMath[2]

1 You can select an input channel of an installed module. However, you cannot select the input channels of a logic module, frequency module, 16-CH voltage input module, 16-CH temperature/voltage input module, CAN bus monitor module, or CAN & LIN bus monitor module.

2 You can use other RMath waveforms as math source waveforms. If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX–1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.

Bit Rate (Bit Rate)

Select the transmission speed of the CAN bus signal to detect.
10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 250k, 500k, 800k, or 1Mbps

Message Format

Select the data frame message format of the CAN bus signal to detect.
STD: Standard format
XTD: Extended format

ID (Hexadecimal (Hex))

Set the data frame message ID of the CAN bus signal to detect.
Standard format (11 bits): 0x000 to 0x7ff
Extended format (29 bits): 0x00000000 to 0x1fffffff

Notes Regarding Using the Digital Filter and Real Time Math

Real Time Math Source Modules and Channels

The modules and channels that you can select as real time math source waveforms (source) are shown below.

Operators and Functions		Input Module Model and RMath (Real Time Math Channel) (Yes: Can be selected, No: Cannot be selected)				
		701250, 701251, 701255, 701260, 701261, 701262, 701265, 701270, 701271, 701275, 720210, 720221[1]	701280	720230	720240[1, 2] 720241[1, 2] (Only usable on the DL850V)	RMath[3]
S1+S2, S1–S2, S1*S2, S1/S2		Yes	Yes	No	Yes	Yes
A(S1)+B(S2)+C, A(S1)–B(S2)+C, A(S1)*B(S2)+C, A(S1)/B(S2)+C		Yes	Yes	No	Yes	Yes
Diff(S1), Integ1(S1), Integ2(S1)		Yes	Yes	No	Yes	Yes
Rotary Angle		Yes[4]	No	Yes[4]	Yes	No
DA		No	No	Yes	No	No
Polynomial		Yes	Yes	No	Yes	Yes
RMS, Power	Math source	Yes	No	No	Yes	Yes
	Edge source	Yes	No	Yes	Yes[*2]	Yes
Power Integ		Yes	No	No	Yes	Yes
Log1, Log2		Yes	Yes	No	Yes	Yes
Sqrt1, Sqrt2		Yes	Yes	No	Yes	Yes
Cos, Sin		Yes[4]	No	Yes[4]	Yes	No
Atan		Yes	Yes	No	Yes	Yes
Electrical Angle	Math source	No	No	Yes	No	No
	Target	Yes	No	No	Yes	Yes
Knock Filter (Only settable on the DL850V)		Yes	No	No	Yes	No
Poly-Add-Sub		Yes	Yes	No	Yes	Yes
Frequency, Period		Yes	No	Yes	Yes	Yes
Edge Count		Yes	No	Yes	Yes[2]	Yes
Resolver		Yes	Yes	No	Yes	Yes
IIR Filter		Yes	Yes	No	Yes	Yes
PWM		Yes	Yes	No	Yes	Yes
Reactive Power(Q)		Yes	No	No	Yes[2]	Yes
CAN ID		Yes[5]	No	No	No	Yes

For the names of the input modules, see the *Getting Started Guide*, IM DL850-03EN.

1 To set the input channels of a 720220 16-CH voltage input module, 720221 16-CH temperature/voltage input module, 720240 CAN bus monitor module, or 720241 CAN & LIN bus monitor module as the source waveforms of real time math, you have to turn on the waveform display (set Display to ON).

2 When the data type (Value Type) is set to Logic, you cannot select the input channels of a 720240 CAN bus monitor module or a 720241 CAN & LIN bus monitor module. Even if the data type is not set to Logic, you cannot use data that exceeds 16 bits in length. However, for the Edge Count function, you can select an input channel of a CAN bus monitor module or a CAN & LIN bus monitor module even if the data type is set to Logic.

3 If you set the real time math channel to RMathX, you can select the RMath waveforms on channels up to RMathX–1. If the real time math channel is RMath1, you cannot use any other RMath waveforms as math source waveforms.
4 If you have turned logic sources on, select an input channel of a 720230 logic module. If logic sources have been turned off, select an input channel of an analog waveform module.
5 The input channels of a 16-CH voltage input module (720220) or 16-CH temperature/voltage input module (720221) cannot be selected.

Math Delay

The real time math delay is “1.4 µs + the digital filter delay + the math delay.”
The digital filter and math delays vary depending on the type of filter and math operation.

- If you are using the result of a real time math channel as the source waveform for another real time math operation, the math delays accumulate.
- For details, see the appendix.

Internal Processing of Real Time Math

The math source waveforms are 16-bit binary data. If they are only 12 bits long, they are converted to 16 bits. Internally, the waveforms are converted to floating-point numbers and calculated.

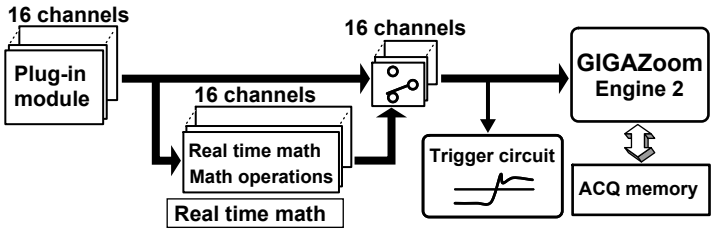
- The math results are converted to 16-bit data in relation to the range (value/div) and are then recorded in acquisition memory.
- The basic display is 2400 LSB/div (the same as the 16-bit analog waveform module).
- For details on the internal math expressions, see the appendix.

Differences between Real Time Math and Standard Math

This section explains the differences between the real time math operations that you configure by pressing CH (/G3 option) and the standard math operations that you configure by pressing MATH.

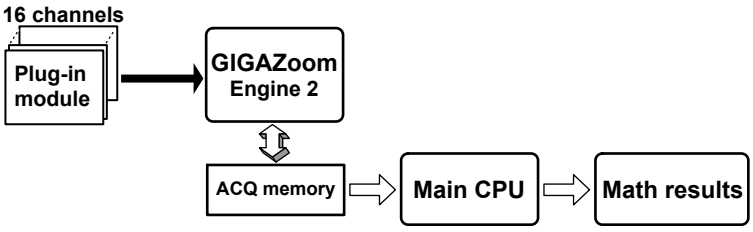
Real Time Math

- Math operations can be performed in real time on waveforms (A/D converted data) that are applied to the input channels of each of the modules.
- Even when the display is in roll mode, you can view the real time math results.
- There are no limits on the record length. Because the data of normal input channels is switched with the real time math results and acquired in acquisition memory, you can specify the same record length as that of the normal input channels.
- You can trigger the DL850/DL850V on real time math results.
- Regardless of the DL850/DL850V sample rate, math operations are always performed on the data that is output from each module at a maximum math rate of 10 MS/s.
- Real time math can be used in all acquisition modes (including the dual capture mode).



Standard Math

- Because waveforms are processed after they are acquired, the waveform update period is long.
- Math cannot be performed when the display is in roll mode.
- Math is performed on data that was acquired into acquisition memory at the DL850/DL850V sample rate.
- Because math results are stored in the main memory of the main CPU, there are limits on the record length (for one channel, the maximum is 1 Mpoint).
- You can not trigger the DL850/DL850V on math results.
- Because math is performed by a general-purpose CPU, a wide variety of expressions are available.



2 Configuring Digital Filter Settings

Digital Filter

The digital filter operation menu has the following settings:

- Filter type: You can select from four filter types—Gauss, Sharp, IIR, and Mean.
- Filter band: You can select the type of filter bands.
- Delay: You can add a delay to the updating of data after data passes through a digital filter.

For details on the digital filter, see chapter 1.

For the filter characteristics, see the appendix.

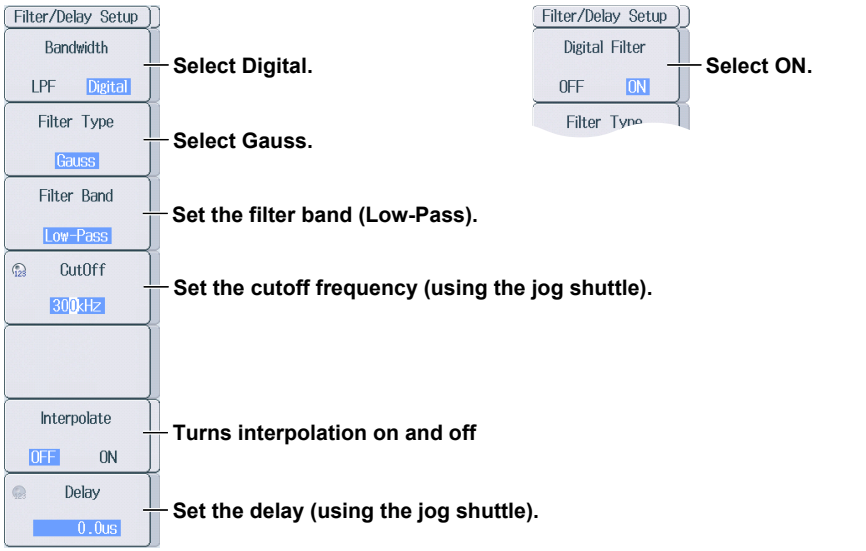
Gauss

This section explains the following settings (which are used when using the Gauss filter):

- Filter type
- Filter band
- Cutoff frequency
- Interpolation
- Delay

CH Menu

1. Press a key from **CH1** to **CH16**, and then the **RealTime Math** soft key to select OFF.
2. Press the **Filter/Delay Setup** soft key and then the **Bandwidth** soft key to select Digital. The following menu appears.



Note

- The same delay is used for all filter types of the same channel.
- To display the Filter/Delay Setup soft key on the setup menu that is displayed when you press a key from CH1 to CH16, press the RealTime Math soft key to select OFF.
- If you want to perform real time math at the same time as the digital filter, press the RealTime Math soft key again to select ON.
- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

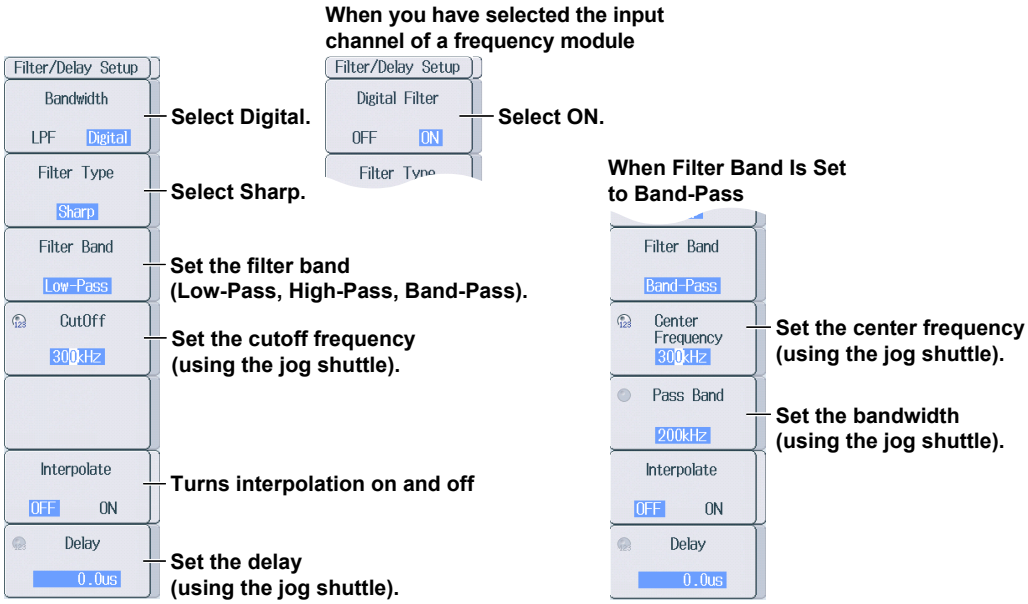
Sharp

This section explains the following settings (which are used when using the Sharp filter):

- Filter type
- Filter band
- Cutoff frequency
- Center frequency
- Bandwidth
- Interpolation
- Delay

CH Menu

1. Press a key from **CH1** to **CH16**, and then the **RealTime Math** soft key to select OFF.
2. Press the **Filter/Delay Setup** soft key and then the **Bandwidth** soft key to select Digital. The following menu appears.



Note

- The same delay is used for all filter types of the same channel.
- To display the Filter/Delay Setup soft key on the setup menu that is displayed when you press a key from CH1 to CH16, press the RealTime Math soft key to select OFF.
- If you want to perform real time math at the same time as the digital filter, press the RealTime Math soft key again to select ON.
- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

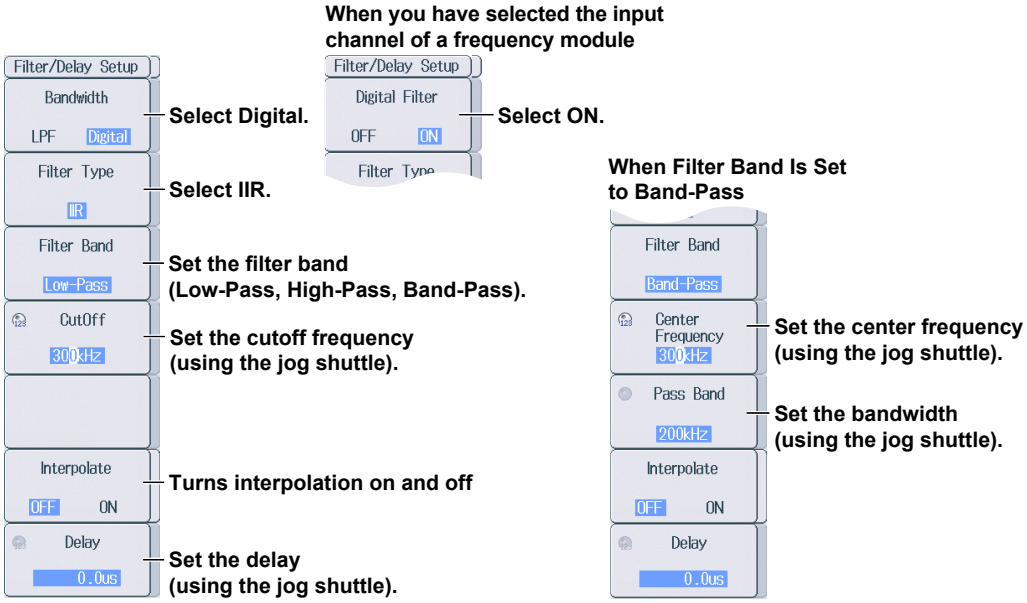
IIR

This section explains the following settings (which are used when using the IIR filter):

- Filter type
- Filter band
- Cutoff frequency
- Center frequency
- Bandwidth
- Interpolation
- Delay

CH Menu

1. Press a key from **CH1** to **CH16**, and then the **RealTime Math** soft key to select OFF.
2. Press the **Filter/Delay Setup** soft key and then the **Bandwidth** soft key to select Digital. The following menu appears.



Note

- The same delay is used for all filter types of the same channel.
- To display the Filter/Delay Setup soft key on the setup menu that is displayed when you press a key from CH1 to CH16, press the RealTime Math soft key to select OFF.
- If you want to perform real time math at the same time as the digital filter, press the RealTime Math soft key again to select ON.
- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

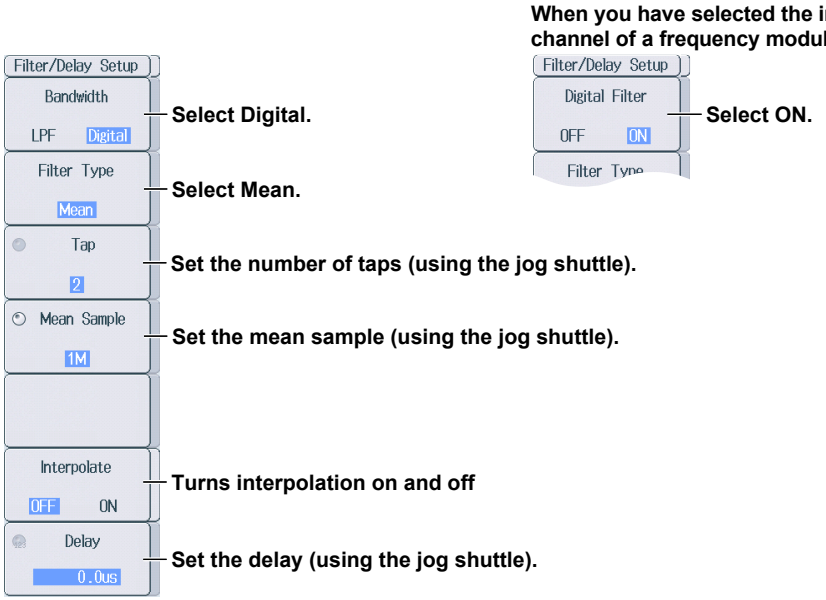
Mean

This section explains the following settings (which are used when using the Mean filter):

- Filter type
- Number of taps
- Mean sample
- Interpolation
- Delay

CH Menu

1. Press a key from **CH1** to **CH16**, and then the **RealTime Math** soft key to select OFF.
2. Press the **Filter/Delay** Setup soft key and then the **Bandwidth** soft key to select Digital. The following menu appears.



Note

- The same delay is used for all filter types of the same channel.
- To display the Filter/Delay Setup soft key on the setup menu that is displayed when you press a key from CH1 to CH16, press the RealTime Math soft key to select OFF.
- If you want to perform real time math at the same time as the digital filter, press the RealTime Math soft key again to select ON.
- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

3 Configuring Real Time Math Settings

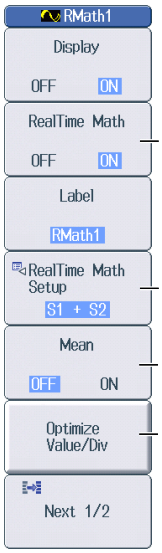
Real Time Math Settings

This section explains the following settings (which are used when performing real time math):

- Real time math on/off
- Real time math settings
- Input settings for all channels

RMath Menu

1. Press a key from **CH1** to **CH16**, and then the **RealTime Math** soft key to select ON to display the following menu.



Turn real time math on.

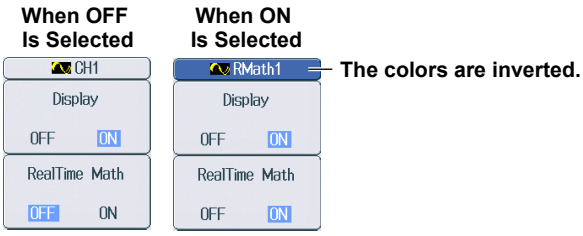
Configure real time math settings.

Turns the mean on and off

Optimizes value/div

Note

- When you turn real time math on, the colors that are used to display the menu title are inverted.



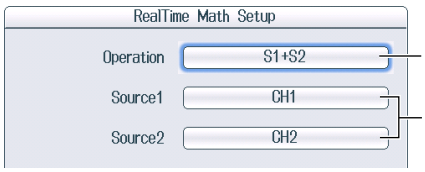
The colors are inverted.

- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

Configuring Real Time Math Settings (RealTime Math Setup)

2. Press the **RealTime Math Setup** soft key to display the following screen.

Example when the Operation is S1+S2



Select an operator or function (see the operations and function that are described later in this section).

Select the math source waveforms (CH1 to CH16,[1] RMath1 to RMath15[2]).

1 You can select channels in which input modules that support basic arithmetic are installed.
2 You can select channels whose numbers are smaller than the channel you are operating.

Operations and Functions

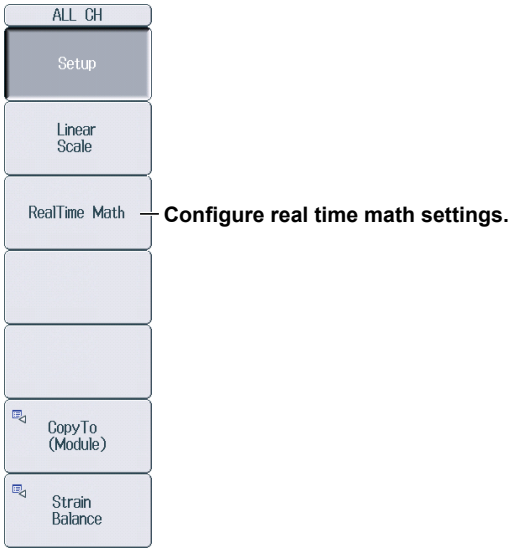
Menu Item	Description	
S1+S2	Basic arithmetic	Addition
S1−S2		Subtraction
S1*S2		Multiplication
S1/S2		Division
A(S1)+B(S2)+C	Basic arithmetic with coefficients	Addition
A(S1)−B(S2)+C		Subtraction
A(S1)*B(S2)+C		Multiplication
A(S1)/B(S2)+C		Division
Diff(S1)	Differentiation	
Integ1(S1)	Integration	Area of the positive amplitude (T-Y waveform)
Integ2(S1)		Area of the positive amplitude minus area of the negative amplitude (T-Y waveform)
Rotary Angle	Angle of rotation	
DA	Logic signal to analog waveform conversion	
Polynomial	Quartic polynomial	
RMS	RMS value	
Power	Effective power	
Power Integ	Effective power integration	
Log1	Common logarithm	Common logarithm of S1/S2
Log2		Common logarithm of S1
Sqrt1	Square root	Square root of “$S1^2 \pm S2^2$”
Sqrt2		Square root of S1
Cos	Cosine	
Sin	Sine	
Atan	Arc tangent	
Electrical Angle	Electrical angle	
Knock Filter	Knocking filter (only on the DL850V)	
Poly-Add-Sub	Polynomial with a coefficient	
Frequency	Frequency	
Period	Period	
Edge Count	Edge count	
Resolver	Resolver	
IIR Filter	IIR Filter	
PWM	Demodulation of the Pulse Width Modulated Signal	
Reactive Power(Q)	Reactive power	
CAN ID	CAN ID detection	

Note

For details on the types of modules that support the operations and functions, see “Notes Regarding Using the Digital Filter and Real Time Math,” in chapter 1.

ALL CH Menu

1. Press **ALL CH** to display the following menu.

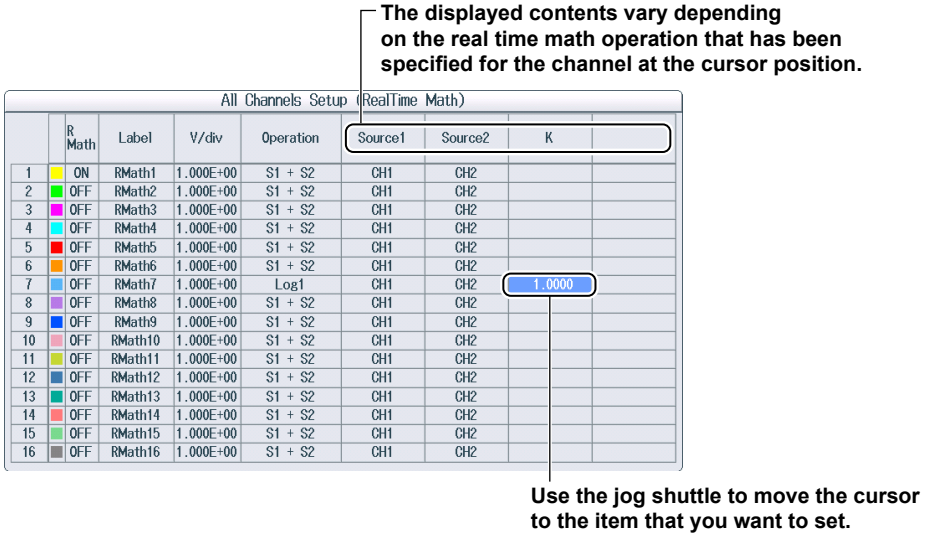


Note

- For information on other features, how to use these features, and handling precautions, see the following manuals.
  - The *Features Guide*, IM DL850-01EN
  - The *User's Manual*, IM DL850-02EN
  - The *Getting Started Guide*, IM DL850-03EN

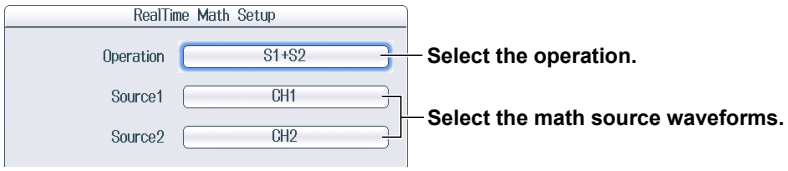
Configuring Real Time Math Settings for All Channels (RealTime Math)

2. Press the **RealTime Math** soft key to display the following screen.


The displayed contents vary depending on the real time math operation that has been specified for the channel at the cursor position.
All Channels Setup (RealTime Math)
R Math
Label
V/div
Operation
Source1
Source2
K
1 ON RMath1 1.000E+00 S1 + S2 CH1 CH2
2 OFF RMath2 1.000E+00 S1 + S2 CH1 CH2
3 OFF RMath3 1.000E+00 S1 + S2 CH1 CH2
4 OFF RMath4 1.000E+00 S1 + S2 CH1 CH2
5 OFF RMath5 1.000E+00 S1 + S2 CH1 CH2
6 OFF RMath6 1.000E+00 S1 + S2 CH1 CH2
7 OFF RMath7 1.000E+00 Log1 CH1 CH2 1.0000
8 OFF RMath8 1.000E+00 S1 + S2 CH1 CH2
9 OFF RMath9 1.000E+00 S1 + S2 CH1 CH2
10 OFF RMath10 1.000E+00 S1 + S2 CH1 CH2
11 OFF RMath11 1.000E+00 S1 + S2 CH1 CH2
12 OFF RMath12 1.000E+00 S1 + S2 CH1 CH2
13 OFF RMath13 1.000E+00 S1 + S2 CH1 CH2
14 OFF RMath14 1.000E+00 S1 + S2 CH1 CH2
15 OFF RMath15 1.000E+00 S1 + S2 CH1 CH2
16 OFF RMath16 1.000E+00 S1 + S2 CH1 CH2
Use the jog shuttle to move the cursor to the item that you want to set.

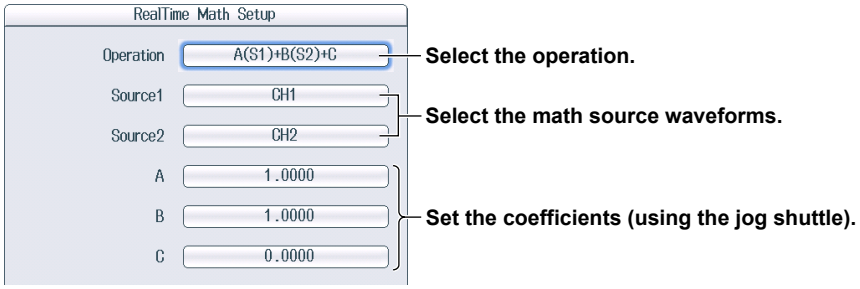
Basic Arithmetic (S1+S2, S1−S2, S1*S2, and S1/S2)

The following screen appears when you select a basic arithmetic operation.



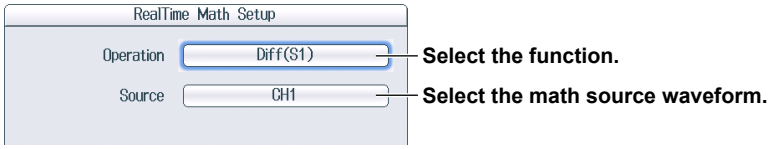
Basic Arithmetic with Coefficients (A(S1)+B(S2)+C, A(S1)−B(S2)+C, A(S1)*B(S2)+C, and A(S1)/B(S2)+C)

The following screen appears when you select a basic arithmetic operation with coefficients.



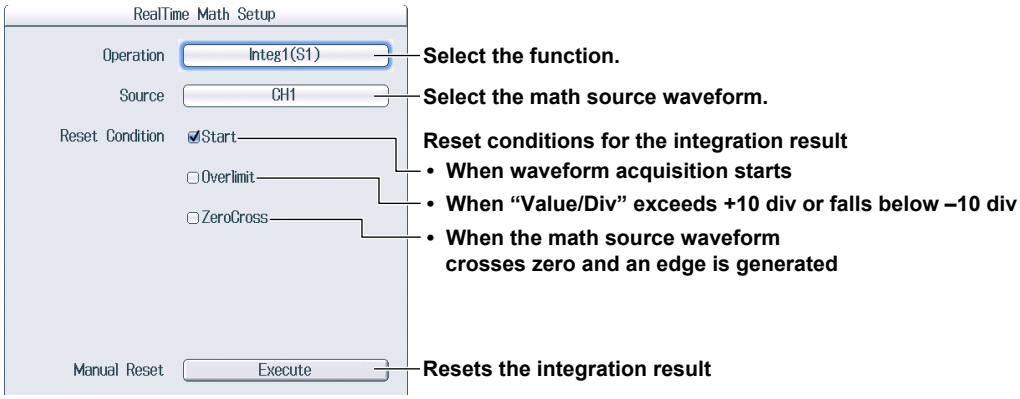
Differentiation (Diff(S1))

The following screen appears when you select the differentiation function.



Integration (Integ1(S1) and Integ2(S2))

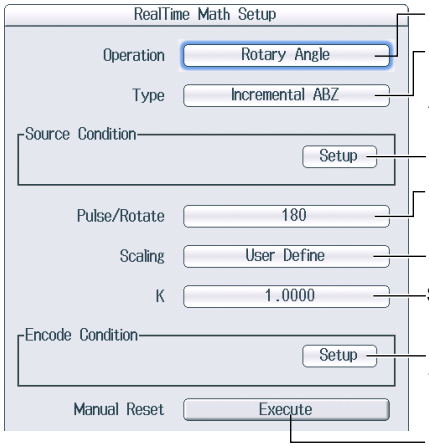
The following screen appears when you select an integration function.



Angle of Rotation (Rotary Angle)

1. The following screen appears when you select the angle-of-rotation function.

- **When the Encoding Type Is Incremental ABZ, Incremental AZ, Absolute 8bit, or Absolute 16bit**



Select the function.

Select the encoding type (Incremental ABZ, Incremental AZ, Absolute 8bit, Absolute 16bit).

Set the source conditions.

Set the number of pulses per rotation (using the jog shuttle).

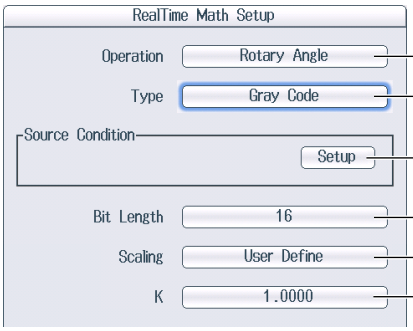
Select the scale (Radian, Degree, User Define).

Set the size of the scale (only when Scaling is set to User Define) **(using the jog shuttle).**

Set the encoding conditions.
You can set the conditions when the encoding type is ABZ or AZ.

Resets the math result

- **When the Encoding Type Is Gray Cord**



Select the function.

Select the encoding type (Gray Cord).

Set the source conditions.

Set the bit length (using the jog shuttle).

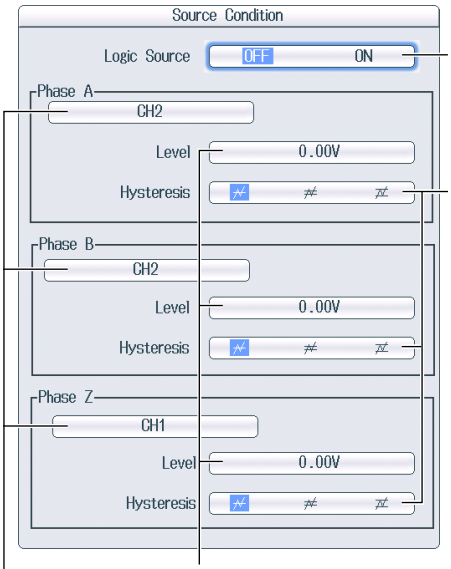
Select the scale (Radian, Degree, User Define).

Set the size of the scale (only when Scaling is set to User Define) **(using the jog shuttle).**

Setting the Source Conditions

2. Under Source Condition, press **Setup** to display the following screen.

- **When the Encoding Type Is Incremental ABZ or Incremental AZ and When the Logic Source Is Off**



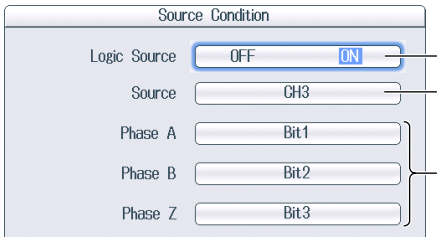
Turn logic sources off.

Set the hysteresis (, ,).

Set the signal level that you want to count (using the jog shuttle).

Select the signal channels for phases A, B, and Z of the analog waveform module.

- **When the Encoding Type Is Incremental ABZ or Incremental AZ and When the Logic Source Is On**

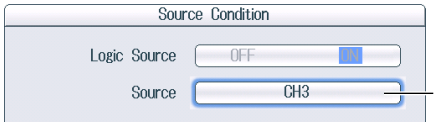


Turn logic sources on.

Select the input channel of the logic module.
The channels of installed logic modules are displayed.

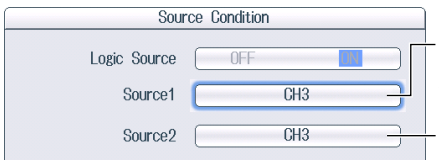
Select the bits of logic signals of phases A, B, and Z (Bit1 to Bit8).

- **When the Encoding Type Is Absolute 8bit**



Select the input channel of the logic module.
The channels of installed logic modules are displayed.

- **When the Encoding Type Is Absolute 16bit or Gray Code**



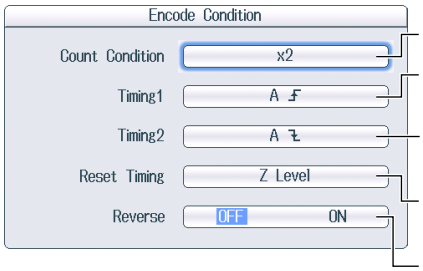
Select the math source logic signal (least significant 8 bits).
The channels of installed logic modules are displayed.

Select the math source logic signal (most significant 8 bits).
The channels of installed logic modules are displayed.

* When the bit length of Gray Code is 8 or less, the Source2 setting is ignored.

Setting the Encoding Conditions

3. Under Encode Condition, press **Setup** to display the following screen.



Set the count condition (x4, x2, x1).

Select the edge to count pulses on (A↓, A↑, B↓, B↑).
This is displayed when Count Condition is set to x2 or x1.

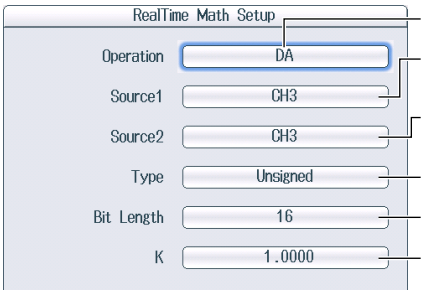
Select the edge to count pulses on (A↓, A↑, B↓, B↑).
This is displayed when Count Condition is set to x2.

Select the edge that you want to use to trigger a reset operation (A↓, A↑, B↓, B↑, Z Level).

Turns rotation direction inversion on and off

Logic Signal to Analog Waveform Conversion (DA)

The following screen appears when you select the logic signal to analog waveform conversion function.



Select the function.

Select the math source logic signal (least significant 8 bits).
The channels of installed logic modules are displayed.

Select the math source logic signal (most significant 8 bits).
The channels of installed logic modules are displayed.

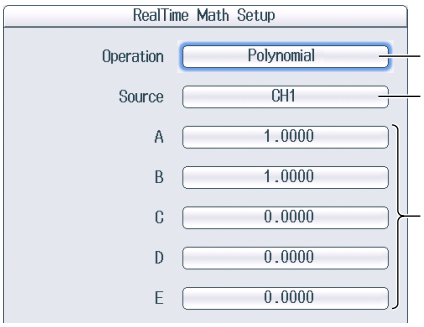
Select the conversion method (Unsigned, Signed, Offset Binary).

Set the bit length (using the jog shuttle).

Set the coefficient (using the jog shuttle).

Quartic Polynomial (Polynomial)

The following screen appears when you select the quartic polynomial function.



Select the function.

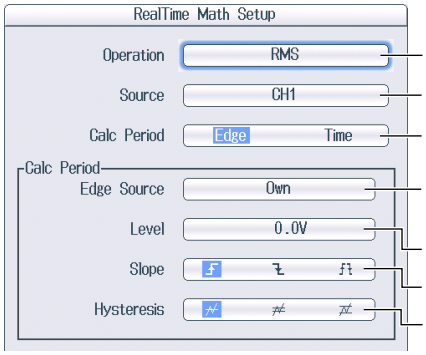
Select the math source waveform.

Set the coefficients (using the jog shuttle).

RMS Value (RMS)

The following screen appears when you select the RMS value function.

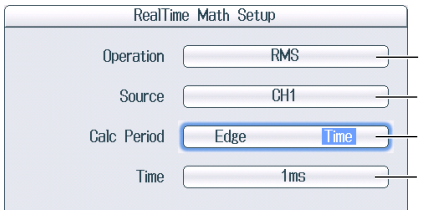
- **If the Calculation Period Is Edge**



Select the function.
Select the math source waveform.
Set the calculation period to Edge.
Select the edge detection source (Own, CH1 to CH16[1], RMath1 to RMath15[2]).
Set the level (using the jog shuttle).
Set the edge detection condition (, ,).
Set the hysteresis (, ,).

1 You can select channels in which input modules that support basic arithmetic are installed.
2 You can select channels whose numbers are smaller than the channel you are operating.

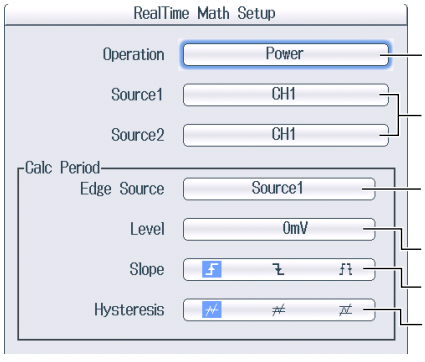
- **If the Calculation Period Is Time**



Select the function.
Select the math source waveform.
Set the calculation period to Time.
Set the time (using the jog shuttle).

Effective Power (Power)

The following screen appears when you select the effective power function.

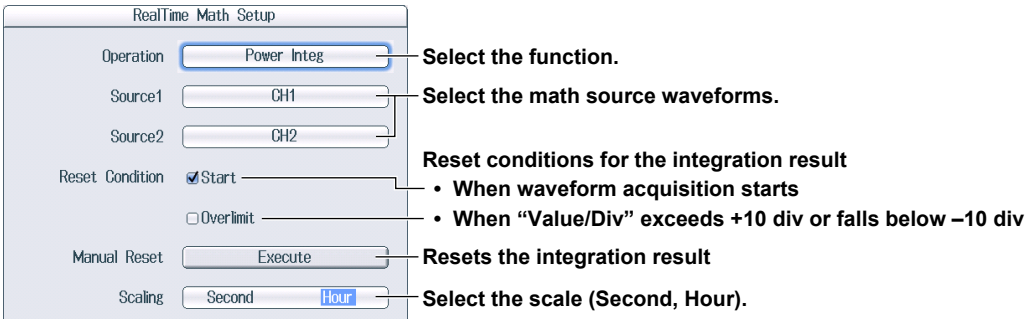


Select the function.
Select the math source waveforms.
Select the edge detection source (Source1, Source2, CH1 to CH16[1], RMath1 to RMath15[2]).
Set the level (using the jog shuttle).
Set the edge detection condition (, ,).
Set the hysteresis (, ,).

1 You can select channels in which input modules that support basic arithmetic are installed.
2 You can select channels whose numbers are smaller than the channel you are operating.

Effective Power Integration (Power Integ)

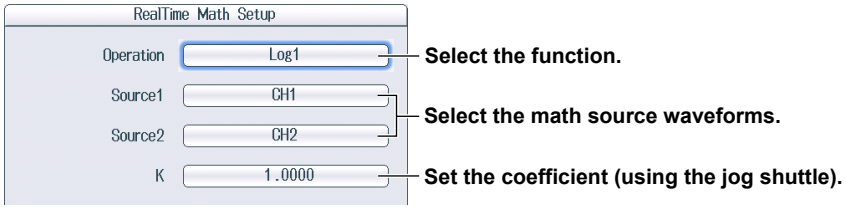
The following screen appears when you select the effective power integration function.



Common Logarithm (Log1 and Log2)

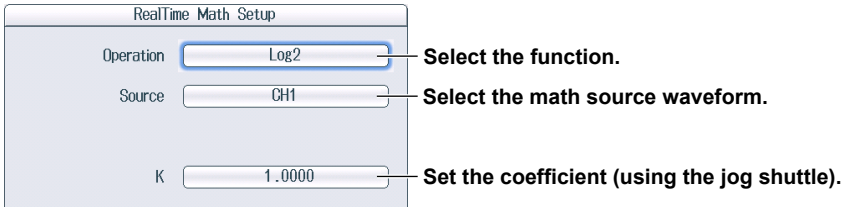
- **Log1**

  The following screen appears when you select the common logarithm function (Log1).



- **Log2**

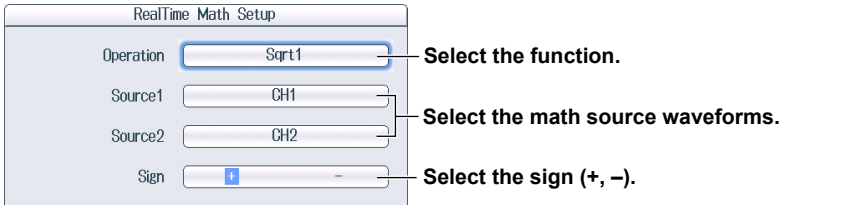
  The following screen appears when you select the common logarithm function (Log2).



Square Root (Sqrt1 and Sqrt2)

- **Sqrt1**

  The following screen appears when you select the square root function (Sqrt1).



Note

When you set Sign to +, the square root of "$S1^2 + S2^2$" is calculated.
When you set Sign to –, the square root of "$S1^2 – S2^2$" is calculated.

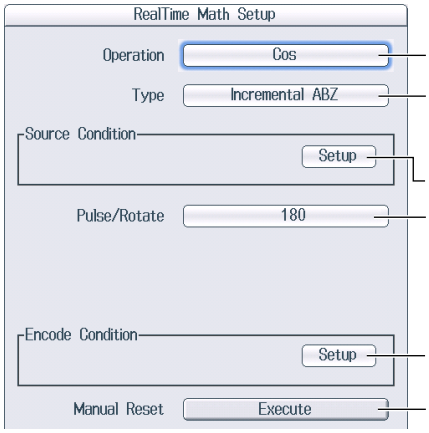
- **Sqrt2**

  The following screen appears when you select the square root function (Sqrt2).

Cosine (Cos) and Sine (Sin)

1. The following screen appears when you select the cosine or sine function.

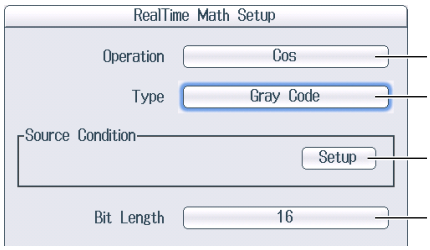
- **When the Encoding Type Is Incremental ABZ, Incremental AZ, Absolute 8bit, or Absolute 16bit**



Select the function.
Select the encoding type (Incremental ABZ, Incremental AZ, Absolute 8bit, Absolute 16bit).
Set the source conditions.
Set the number of pulses per rotation (using the jog shuttle).
Set the encoding conditions.*
Resets the math result *

* You can set the conditions when the encoding type is ABZ or AZ.

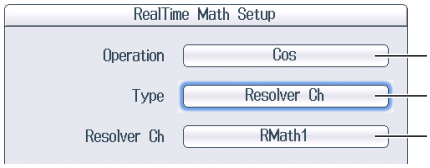
- **When the Encoding Type Is Gray Code**



Select the function.
Select the encoding type (Gray Cord).
Set the source conditions.
Set the bit length (using the jog shuttle).

- **When the Encoding Type Is Resolver Ch**

  You can only configure the settings when there is a channel that has been defined with the resolver function.



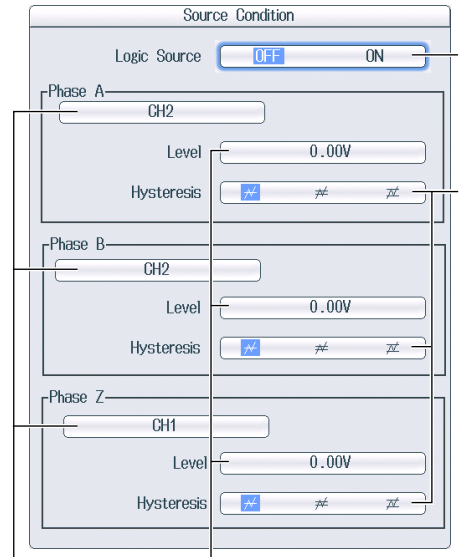
Select the function.
Select the encoding type (Resolver Ch).
Select the resolver channel*
The channels that have been defined with the resolver function are displayed.

* You can select channels whose numbers are smaller than the channel you are operating.

Setting the Source Conditions

2. Under Source Condition, press **Setup** to display the following screen.

- **When the Encoding Type Is Incremental ABZ or Incremental AZ and When the Logic Source Is Off**



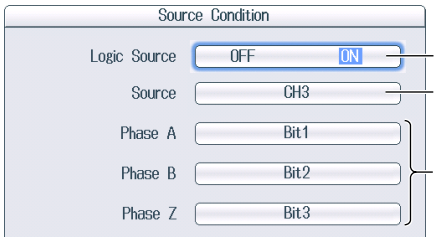
Turn logic sources off.

Set the hysteresis (, ,).

Set the signal level that you want to count (using the jog shuttle).

Select the signal channels for phases A, B, and Z of the analog waveform module.

- **When the Encoding Type Is Incremental ABZ or Incremental AZ and When the Logic Source Is On**

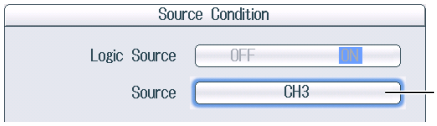


Turn logic sources on.

Select the input channel of the logic module.
The channels of installed logic modules are displayed.

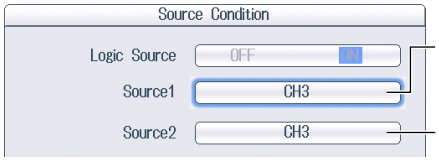
Select the bits of logic signals of phases A, B, and Z (Bit1 to Bit8).

- **When the Encoding Type Is Absolute Encode 8bit**



Select the input channel of the logic module.
The channels of installed logic modules are displayed.

- **When the Encoding Type Is Absolute Encode 16bit or Gray Code**



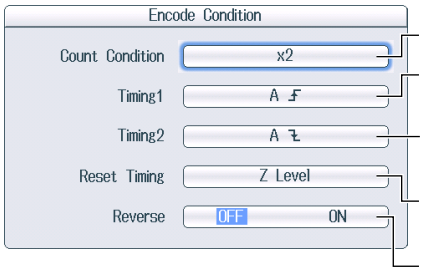
Select the math source logic signal (least significant 8 bits).
The channels of installed logic modules are displayed.

Select the math source logic signal (most significant 8 bits).
The channels of installed logic modules are displayed.

* When the bit length of Gray Code is 8 or less, the Source2 setting is ignored.

Setting the Encoding Conditions

3. Under Encode Condition, press **Setup** to display the following screen.



Set the count condition (x4, x2, x1).

Select the edge to count pulses on (A ↓, A ↑, B ↓, B ↑).
This is displayed when Count Condition is set to x2 or x1.

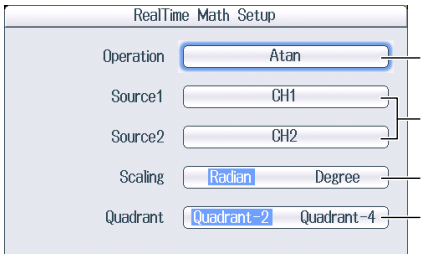
Select the edge to count pulses on (A ↓, A ↑, B ↓, B ↑).
This is displayed when Count Condition is set to x2.

Select the edge that you want to use to trigger a reset operation (A ↓, A ↑, B ↓, B ↑, Z Level).

Turns rotation direction inversion on and off

Arc Tangent (Atan)

The following screen appears when you select the arc tangent function.



Select the function.

Select the math source waveforms.

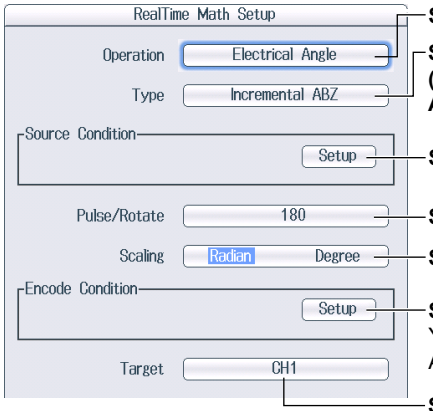
Select the scale (Radian, Degree).

Select the quadrant range (Quadrant-2, Quadrant-4).

Electrical Angle (Electrical Angle)

1. The following screen appears when you select the electrical angle function.

- **When the Encoding Type Is Incremental ABZ, Incremental AZ, Absolute 8bit, or Absolute 16bit**



Select the function.

Select the encoding type (Incremental ABZ, Incremental AZ, Absolute 8bit, Absolute 16bit).

Set the source conditions.

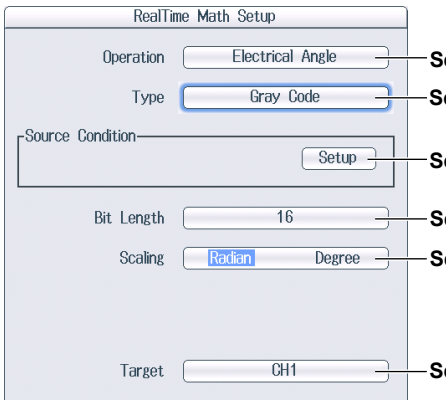
Set the number of pulses per rotation (using the jog shuttle).

Select the scale (Radian, Degree).

Set the encoding conditions.
You can set the conditions when the encoding type is ABZ or AZ.

Select the target (CH1 to CH16[1], RMath1 to RMath15[2]).

- **When the Encoding Type Is Gray Code**



Select the function.

Select the encoding type (Gray Cord).

Set the source conditions.

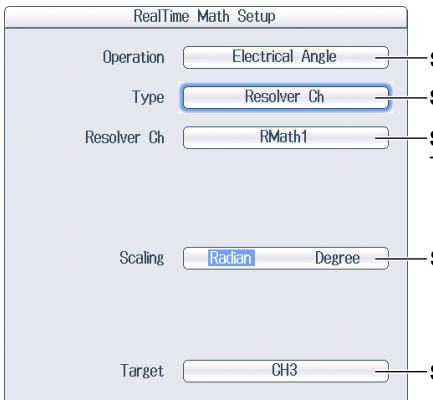
Set the bit length (using the jog shuttle).

Select the scale (Radian, Degree).

Select the target (CH1 to CH16[1], RMath1 to RMath15[2]).

- **When the Encoding Type Is Resolver Ch**

  You can only configure the settings when there is a channel that has been defined with the resolver function.



Select the function.

Select the encoding type (Resolver Ch).

Select the resolver channel[2]
The channels that have been defined with the resolver function are displayed.

Select the scale (Radian, Degree).

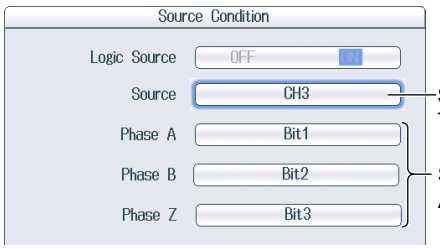
Select the target (CH1 to CH16[1], RMath1 to RMath15[2]).

1 You can select channels in which input modules that support basic arithmetic are installed.
2 You can select channels whose numbers are smaller than the channel you are operating.

Setting the Source Conditions

2. Under Source Condition, press **Setup** to display the following screen.

- **When the Encoding Type is Incremental ABZ or Incremental AZ**



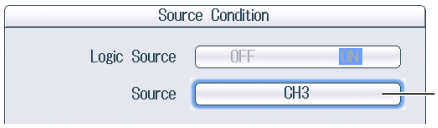
Select the input channel of the logic module.
The channels of installed logic modules are displayed.

Select the bits of logic signals of phases A, B, and Z (Bit1 to Bit8).

Note

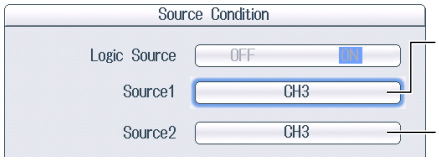
You cannot use analog waveforms as sources.

- **When the Encoding Type Is Absolute 8bit**



Select the input channel of the logic module.
The channels of installed logic modules are displayed.

- **When the Encoding Type Is Absolute 16bit or Gray Code**



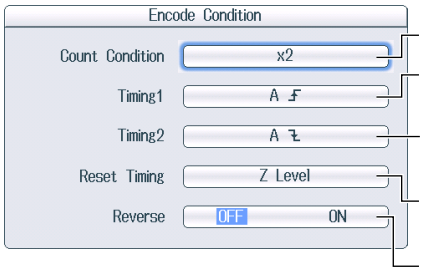
Select the math source logic signal (least significant 8 bits).
The channels of installed logic modules are displayed.

Select the math source logic signal (most significant 8 bits).
The channels of installed logic modules are displayed.

* When the bit length of Gray Code is 8 or less, the Source2 setting is ignored.

Setting the Encoding Conditions

3. Under Encode Condition, press **Setup** to display the following screen.



Set the count condition (x4, x2, x1).

Select the edge to count pulses on (A↓, A↑, B↓, B↑).
This is displayed when Count Condition is set to x2 or x1.

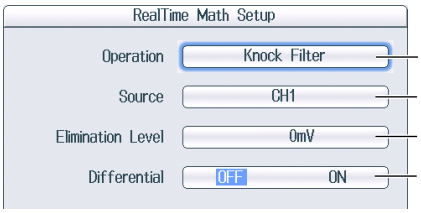
Select the edge to count pulses on (A↓, A↑, B↓, B↑).
This is displayed when Count Condition is set to x2.

Select the edge that you want to use to trigger a reset operation (A↓, A↑, B↓, B↑, Z Level).

Turns rotation direction inversion on and off

Knocking Filter (Knock Filter; only on the DL850V)

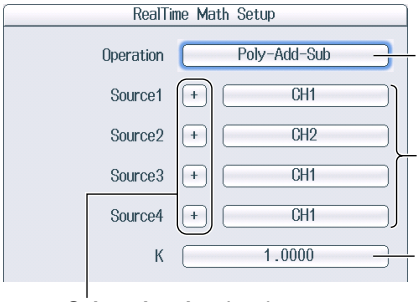
The following screen appears when you select the knocking filter function.



Select the function.
Select the math source waveform.
Set the elimination level (using the jog shuttle).
Turns differentiation on and off

Polynomial with a Coefficient (Poly-Add-Sub)

The following screen appears when you select the polynomial with a coefficient function.

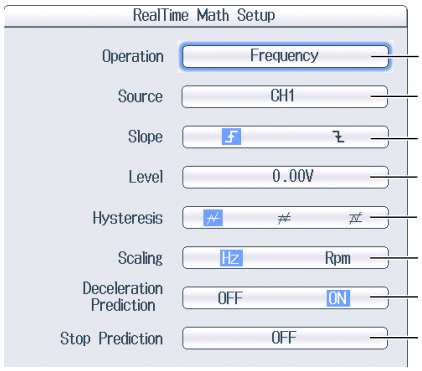


Select the function.
Select the math source waveforms.
Set the coefficient (using the jog shuttle).

Select the sign (+, –).
Press SET to switch between the positive and negative signs.

Frequency (Frequency)

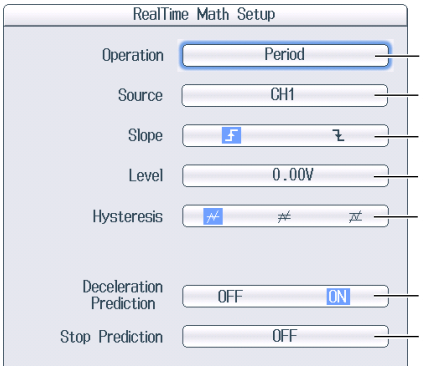
The following screen appears when you select the frequency function.



Select the function.
Select the math source waveform.
Set the edge detection condition (,).
Set the level (using the jog shuttle).
Set the hysteresis (, ,).
Select the scale (Hz, Rpm).
Select the deceleration prediction (OFF, ON).
Select the stop prediction (OFF, 2, 4, 8, 16).

Period (Period)

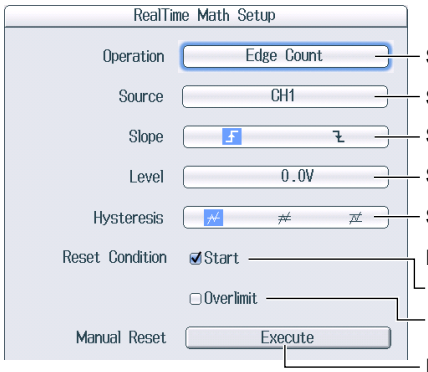
The following screen appears when you select the period function.



Select the function.
Select the math source waveform.
Set the edge detection condition (,).
Set the level (using the jog shuttle).
Set the hysteresis (, ,).
Select the deceleration prediction (OFF, ON).
Select the stop prediction (OFF, 2, 4, 8, 16).

Edge Count (Edge Count)

The following screen appears when you select the edge count function.



Select the function.

Select the math source waveform.

Set the edge detection condition (,).

Set the level (using the jog shuttle).

Set the hysteresis (, ,).

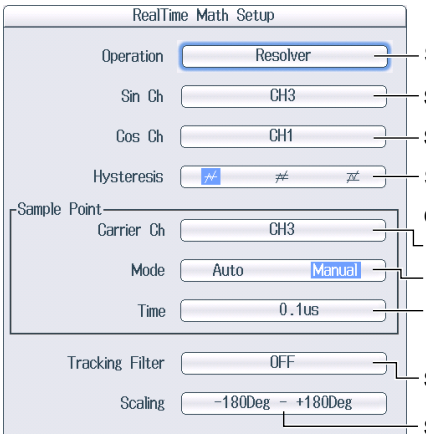
Edge count result reset conditions

- **When the edge count operation begins**
- **When "Value/Div" exceeds +10 div or falls below –10 div**

Resets the edge count result

Resolver (Resolver)

The following screen appears when you select the resolver function.



Select the function.

Select the sine phase signal (CH1 to CH16[1], RMath1 to RMath15[2]).

Select the cosine phase signal (CH1 to CH16[1], RMath1 to RMath15[2]).

Set the hysteresis (, ,).

Configure the sample point.

- **Select the excitation signal (CH1 to CH16[1], RMath1 to RMath15[2]).**
- **Set the Mode (Auto, Manual).**
- **Set the move time of the sample point** (only when Mode is set to Manual) **(using the jog shuttle).**

Select the tracking filter (OFF, 2kHz, 1kHz, 250Hz, 100Hz).

Select the scale
(–180Deg − +180Deg, 0Deg − 360Deg, –PI − +PI, 0 − 2PI).

* "PI" is displayed as "π" on the screen.

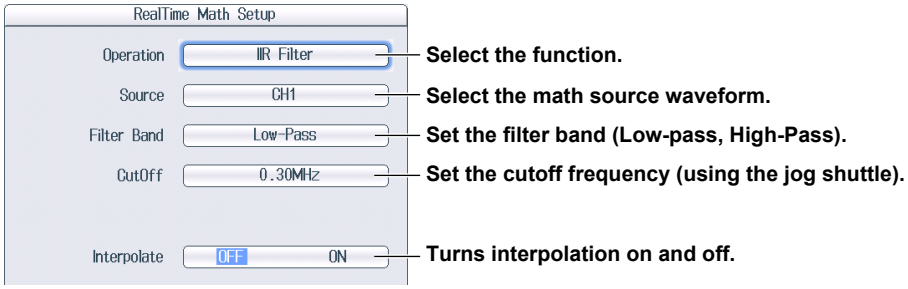
1 You can select channels in which input modules that support basic arithmetic are installed.

2 You can select channels whose numbers are smaller than the channel you are operating.

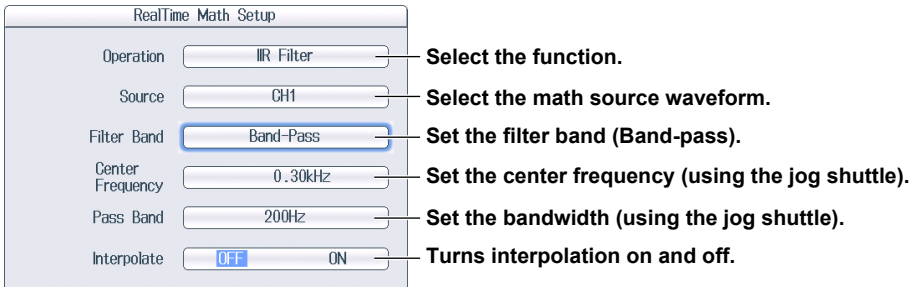
IIR Filter (IIR Filter)

The following screen appears when you select the IIR filter function.

- **When Filter Band Is Set to Low-Pass or High-Pass**

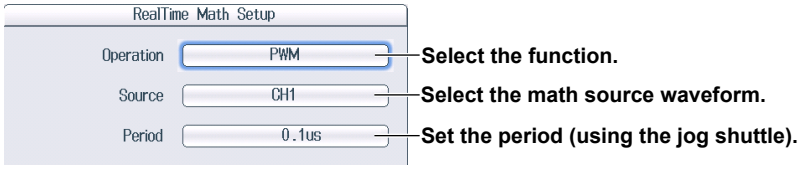


- **When Filter Band Is Set to Band-Pass**



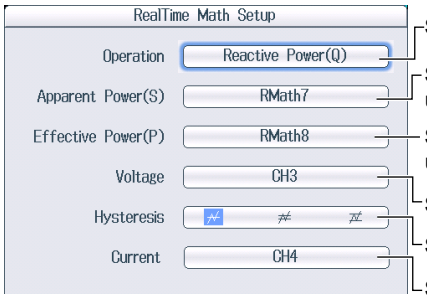
Demodulation of the Pulse Width Modulated Signal (PWM)

When you select the function that is used to demodulate pulse width modulated signals, the following screen appears.



Reactive Power (Reactive Power(Q))

The following screen appears when you select the reactive power (Q) function.



Select the function.

Select the real time math channel (RMath channel) used to calculate the apparent power.

Select the real time math channel (RMath channel) used to calculate the effective power.

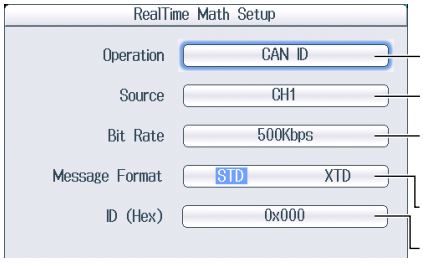
Select the voltage channel used to derive the reactive power.

Set the hysteresis for the selected voltage. (, ,)

Select the current channel used to derive the reactive power.

CAN ID Detection (CAN ID)

The following screen appears when you select the CAN ID function.



Select the function.

Select the detection source waveform.

Select the bit rate (10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 250k, 500k, 800k, 1Mbps).

Select the message format (STD, XTD).

Set the message ID.

4 Commands

Command	Function	Page
RMATh CHANnel Group		
:CHANnel<x1>:RMATh:ATANgent:SCALe	Sets or queries the scale of the specified channel's arc tangent operation.	4-5
:CHANnel<x>:RMATh:ATANgent:QUADrant	Sets or queries the quadrant range for the arctangent calculation of the specified channel.	4-5
:CHANnel<x>:RMATh:AVALue	Sets or queries coefficient A of the currently specified real time math operation.	4-5
:CHANnel<x>:RMATh:BVALue	Sets or queries coefficient B of the currently specified real time math operation.	4-5
:CHANnel<x>:RMATh:BWIDth:BAND	Sets or queries the band of the specified channel's digital filter.	4-5
:CHANnel<x>:RMATh:BWIDth:CFRequency	Sets or queries the center frequency of the bandpass filter of the specified channel's digital filter.	4-5
:CHANnel<x>:RMATh:BWIDth:CUToff	Sets or queries the cutoff frequency of the specified channel's digital filter.	4-6
:CHANnel<x>:RMATh:BWIDth:INTerpo	Sets or queries the interpolation function of the specified channel's digital filter.	4-6
:CHANnel<x>:RMATh:BWIDth:MEAN?	Queries all mean settings of the specified channel's digital filter.	4-6
:CHANnel<x>:RMATh:BWIDth:MEAN:SAMPle (Base Sample)	Sets or queries the sample of the mean of the specified channel's digital filter.	4-6
:CHANnel<x>:RMATh:BWIDth:MEAN:TAP	Sets or queries the taps of the mean of the specified channel's digital filter.	4-7
:CHANnel<x>:RMATh:BWIDth:MODE	Sets or queries the filter mode of the specified channel.	4-7
:CHANnel<x>:RMATh:BWIDth:PBANd (Pass Band)	Sets or queries the bandwidth of the bandpass filter of the specified channel' s digital filter.	4-7
:CHANnel<x>:RMATh:BWIDth:TYPE	Sets or queries the digital filter type of the specified channel.	4-7
:CHANnel<x>:RMATh:CANId:BRATe (Bit Rate)	Sets or queries the CAN ID bit rate of the specified channel.	4-8
:CHANnel<x>:RMATh:CANId:MFORmat (Message Format)	Sets or queries the CAN ID message format of the specified channel.	4-8
:CHANnel<x>:RMATh:CANId:MID (Message ID)	Sets or queries the CAN ID message ID of the specified channel.	4-8
:CHANnel<x>:RMATh:CANId:SOURce	Sets or queries the CAN ID detection source waveform of the specified channel.	4-8
:CHANnel<x>:RMATh:CVALue	Sets or queries coefficient C of the currently specified real time math operation.	4-8
:CHANnel<x>:RMATh:DA?	Queries all logic signal to analog waveform conversion settings.	4-8
:CHANnel<x>:RMATh:DA:BLENgth (Bit Length)	Sets or queries the logic signal to analog waveform conversion bit length.	4-8
:CHANnel<x1>:RMATh:DA:SOURce<x2>	Sets or queries the math source waveform that you want to convert into an analog waveform.	4-8
:CHANnel<x>:RMATh:DA:TYPE	Sets or queries the logic signal to analog waveform conversion method (type).	4-9
:CHANnel<x>:RMATh:DELay	Sets or queries the delay of the specified channel.	4-9
:CHANnel<x>:RMATh:DVALue	Sets or queries coefficient D of the currently specified real time math operation.	4-9
:CHANnel<x>:RMATh:ECOunt? (Edge Count)	Queries all reset condition settings for the specified channel's edge count operation.	4-9
:CHANnel<x>:RMATh:ECOunt:MRESet:EXECute (Manual Reset)	Resets the counter of the specified channel's edge count operation.	4-9
:CHANnel<x>:RMATh:ECOunt:OVERange	Sets or queries whether the edge count is reset when an over limit occurs for the specified channel's edge count operation.	4-9
:CHANnel<x>:RMATh:ECOunt:SRESet (Start Reset)	Sets or queries whether the edge count is reset when the edge count operation starts for the specified channel.	4-9
:CHANnel<x>:RMATh:EVALue	Sets or queries coefficient E of the currently specified real time math operation.	4-9
:CHANnel<x>:RMATh:FREQ?	Queries all the settings for the specified channel's frequency, period, and edge count (excluding reset) operations.	4-10
:CHANnel<x>:RMATh:FREQ:BIT	Sets or queries the math source waveform (the source bit) for the specified channel's frequency, period, and edge count operations (when the source is a logic channel).	4-10
:CHANnel<x>:RMATh:FREQ:DECeleration	Sets or queries whether frequency and period computation's deceleration prediction is turned on.	4-10

Command	Function	Page
:CHANnel<x>:RMATh:FREQ:HYSTeresis	Sets or queries the detection hysteresis for the specified channel's frequency, period, and edge count operations.	4-10
:CHANnel<x>:RMATh:FREQ:LEVel	Sets or queries the detection level for the specified channel's frequency, period, and edge count operations.	4-10
:CHANnel<x>:RMATh:FREQ:SCALe	Sets or queries the scale of the specified channel's frequency operation.	4-10
:CHANnel<x>:RMATh:FREQ:SLOPe	Sets or queries the detection slope for the specified channel's frequency, period, and edge count operations.	4-10
:CHANnel<x>:RMATh:FREQ:SOURce	Sets or queries the math source waveform for the specified channel's frequency, period, and edge count operations.	4-11
:CHANnel<x>:RMATh:FREQ:STOPpredict	Sets or queries whether frequency and period computation's stop prediction is turned on.	4-11
:CHANnel<x1>:RMATh:IFILter?	Queries all IIR filter operation settings.	4-11
:CHANnel<x1>:RMATh:IFILter:BAND	Sets or queries the band of the IIR filter operation.	4-11
:CHANnel<x1>:RMATh:IFILter:CUToff	Sets or queries the cutoff frequency of the IIR filter operation.	4-11
:CHANnel<x1>:RMATh:IFILter:CFRequency	Sets or queries the center frequency of the bandpass filter of the IIR filter operation.	4-11
:CHANnel<x1>:RMATh:IFILter:PBANd	Sets or queries the bandwidth of the bandpass filter of the IIR filter operation.	4-12
:CHANnel<x1>:RMATh:IFILter:INTerpo	Sets or queries whether interpolation is used with the IIR filter operation.	4-12
:CHANnel<x>:RMATh:INTegral?	Queries all integration settings of the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:MRESet:EXECute (Manual Reset)	Resets the integrated value of the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:OVERange	Sets or queries whether the integrated value is reset when an over limit occurs for the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:SRESet (Start Reset)	Sets or queries whether the integrated value is reset when integration starts for the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:ZRESet?	Queries all settings related to the integrated value being reset when the signal crosses zero in integration of the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:ZRESet:HYSTeresis	Sets or queries the hysteresis that is used for resetting the integrated value when the signal crosses zero for the specified channel.	4-12
:CHANnel<x>:RMATh:INTegral:ZRESet:MODE	Sets or queries whether the integrated value is reset when the signal crosses zero for the specified channel.	4-13
:CHANnel<x>:RMATh:INTegral:ZRESet:SLOPe	Sets or queries the slope that is used for resetting the integrated value when the signal crosses zero for the specified channel.	4-13
:CHANnel<x>:RMATh:KNOCkflt?	Queries all knocking filter settings of the specified channel.	4-13
:CHANnel<x>:RMATh:KNOCkflt:DIFFerential	Sets or queries the differentiation on/off status of the specified channel's knocking filter.	4-13
:CHANnel<x>:RMATh:KNOCkflt:ELEVel	Sets or queries the elimination level of the specified channel's knocking filter.	4-13
:CHANnel<x>:RMATh:LABel	Sets or queries the label of the specified RMath channel (the specified channel when real time math is turned on).	4-13
:CHANnel<x>:RMATh:MAVG (Moving Average)	Sets or queries the on/off status of the mean of the specified RMath channel (the specified channel when real time math is turned on).	4-13
:CHANnel<x>:RMATh:MODE	Sets or queries the real time math on/off status of the specified channel.	4-14
:CHANnel<x>:RMATh:OFFSet	Sets or queries the offset of the specified RMath channel (the specified channel when real time math is turned on).	4-14
:CHANnel<x>:RMATh:OPERation	Sets or queries the operation of the specified real time math channel.	4-14
:CHANnel<x>:RMATh:OPTimize	Optimizes the vertical scale of the specified channel that will be used in real time math.	4-14
:CHANnel<x>:RMATh:PASub:SIGN	Sets or queries the signs of the sources for the polynomial with a coefficient operation of the specified channel.	4-14
:CHANnel<x>:RMATh:PINTegral?	Queries all effective power integration settings of the specified channel.	4-14
:CHANnel<x>:RMATh:PINTegral:MRESet:EXECute	Resets the effective power integration of the specified channel.	4-14
:CHANnel<x>:RMATh:PINTegral:OVERange	Sets or queries whether the integrated power value of the specified channel is reset when an over limit occurs during effective power integration.	4-14
:CHANnel<x>:RMATh:PINTegral:SCALe	Sets the reference time for the effective power integration of the specified channel.	4-15
:CHANnel<x>:RMATh:PINTegral:SRESet	Sets or queries whether the integrated value is reset when the effective power integration starts for the specified channel.	4-15
:CHANnel<x>:RMATh:POSition	Sets or queries the vertical position of the specified RMath channel (the specified channel when real time math is turned on).	4-15

Command	Function	Page
:CHANnel<x>:RMATh:POWer?	Queries all effective power calculation period settings of the specified channel.	4-15
:CHANnel<x>:RMATh:POWer:TERM:EBIT	Sets or queries the effective power calculation period's edge detection math source waveform of the specified channel (when a logic channel is being used as the edge detection channel).	4-15
:CHANnel<x>:RMATh:POWer:TERM:EHYSteresis	Sets or queries the effective power calculation period's detection hysteresis of the specified channel.	4-15
:CHANnel<x>:RMATh:POWer:TERM:ELEVel	Sets or queries the effective power calculation period's detection level of the specified channel.	4-15
:CHANnel<x>:RMATh:POWer:TERM:ESLope	Sets or queries the effective power calculation period's detection slope of the specified channel.	4-16
:CHANnel<x>:RMATh:POWer:TERM:ESOurce	Sets or queries the effective power calculation period's edge detection math source waveform of the specified channel.	4-16
:CHANnel<x1>:RMATh:PWM:PERiod	Sets or queries the period of the PWM operation.	4-16
:CHANnel<x>:RMATh:RANGle?	Queries all settings related to the angle-of-rotation, electrical angle, sine, and cosine operations of the specified channel.	4-16
:CHANnel<x>:RMATh:RANGle:BLENgth	Sets or queries the bit length when the encoding type is GRAY for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-16
:CHANnel<x>:RMATh:RANGle:CCONdition	Sets or queries the resolution for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-16
:CHANnel<x>:RMATh:RANGle:ETYPe (Edge Type)	Sets or queries the encoding type for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-17
:CHANnel<x1>:RMATh:RANGle:HYSTeresis<x2>	Sets or queries the slope for the specified math source waveform for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-17
:CHANnel<x1>:RMATh:RANGle:LEVel<x2>	Sets or queries the detection level for the specified math source waveform for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-17
:CHANnel<x>:RMATh:RANGle:LOGic?	Queries all the math source waveform settings for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-17
:CHANnel<x>:RMATh:RANGle:LOGic:MODE	Sets or queries the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-17
:CHANnel<x1>:RMATh:RANGle:LOGic:SBIT<x2> (Source BIT)	Sets or queries the source bit when the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations is logic.	4-17
:CHANnel<x1>:RMATh:RANGle:LOGic:SOURce<x2>	Sets or queries the math source waveform when the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations is logic.	4-18
:CHANnel<x1>:RMATh:RANGle:MRESet:EXECute	Resets the angle of the specified channel's angle operations.	4-18
:CHANnel<x>:RMATh:RANGle:PROTate (Pulse per Rotate)	Sets or queries the number of pulses per rotation for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-18
:CHANnel<x>:RMATh:RANGle:REVerse	Sets or queries whether the rotation direction is inverted for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-18
:CHANnel<x1>:RMATh:RANGle:RSOurce (Resolver Source Ch)	Sets or queries the math source waveform when the encoding type of the angle-of-rotation, sine, and cosine operations is RESolver.	4-18
:CHANnel<x>:RMATh:RANGle:RTIMing (Reset Timing)	Sets or queries the timing that will be used to reset the number of rotations for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-18
:CHANnel<x1>:RMATh:RANGle:SCALe	Sets or queries the scale of the specified channel's angle-of-rotation and electrical angle operations.	4-19
:CHANnel<x>:RMATh:RANGle:SLOGic (Source Logic)	Sets or queries the math source waveform type for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-19
:CHANnel<x1>:RMATh:RANGle:SOURce<x2>	Sets or queries the math source waveform when the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations is not logic.	4-19
:CHANnel<x1>:RMATh:RANGle:TIMing<x2> (Edge Timing)	Sets or queries the edge detection timing for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.	4-19
:CHANnel<x1>:RMATh:RESolver?	Queries all resolver operation settings.	4-19
:CHANnel<x1>:RMATh:RESolver:SOURce<x2>	Sets or queries the math source waveform of the resolver operation.	4-19
:CHANnel<x1>:RMATh:RESolver:SMODe(Sample Mode)	Sets or queries the sample mode of the resolver operation.	4-20

Command	Function	Page
:CHANnel<x1>:RMATh:RESolver:HYSTeresis	Sets or queries the hysteresis of the resolver operation when the sample mode is set to AUTO.	4-20
:CHANnel<x1>:RMATh:RESolver:STIMe(Sampling Time)	Sets or queries the time from the excitation waveform edge of the resolver operation when the sample mode is set to MANual.	4-20
:CHANnel<x1>:RMATh:RESolver:TFILter	Sets or queries the tracking filter of the resolver operation.	4-20
:CHANnel<x1>:RMATh:RESolver:SCALe	Sets or queries the scale of the resolver operation.	4-20
:CHANnel<x>:RMATh:RMS?	Queries all RMS calculation period settings of the specified channel.	4-20
:CHANnel<x>:RMATh:RMS:TERM:EBIT	Sets or queries the edge detection math source waveform (the detection bit) for when the RMS calculation period of the specified channel is set to edge (when a logic channel is being used as the edge detection channel).	4-20
:CHANnel<x>:RMATh:RMS:TERM:EHYSteresis	Sets or queries the detection hysteresis for when the RMS calculation period of the specified channel is set to edge.	4-21
:CHANnel<x>:RMATh:RMS:TERM:ELEVel	Sets or queries the detection level for when the RMS calculation period of the specified channel is set to edge.	4-21
:CHANnel<x>:RMATh:RMS:TERM:ESLope	Sets or queries the detection slope for when the RMS calculation period of the specified channel is set to edge.	4-21
:CHANnel<x>:RMATh:RMS:TERM:ESOurce	Sets or queries the edge detection math source waveform for when the RMS calculation period of the specified channel is set to edge.	4-21
:CHANnel<x>:RMATh:RMS:TERM:MODE	Sets or queries the RMS calculation period mode of the specified channel.	4-21
:CHANnel<x>:RMATh:RMS:TERM:TIME	Sets or queries the interval for when the RMS calculation period of the specified channel is set to time.	4-22
:CHANnel<x>:RMATh:RPOWer:SOURce<x2>	Sets or queries the apparent-power, effective-power, voltage, or current channel used to calculate the reactive power of the specified channel.	4-22
:CHANnel<x>:RMATh:RPOWer:VOLTage:HYSTeresis	Sets or queries the hysteresis of the voltage channel used to calculate the reactive power of the specified channel.	4-22
:CHANnel<x1>:RMATh:SC<x2>	Sets or queries source waveforms 1 to 3 of the currently specified real time math operation.	4-22
:CHANnel<x>:RMATh:SC4	Sets or queries source waveform 4 for the polynomial with a coefficient operation of the specified real time math channel.	4-22
:CHANnel<x>:RMATh:SCALe	Sets or queries the two ends of the scale of the specified RMath channel (the specified channel when real time math is turned on).	4-22
:CHANnel<x1>:RMATh:SQRT1:SIGN	Sets or queries the sign for the specified channel's square root operation.	4-23
:CHANnel<x>:RMATh:UNIT	Sets or queries the unit string of the specified RMath channel (the specified channel when real time math is turned on).	4-23
:CHANnel<x>:RMATh:VARiable	Sets or queries the vertical scale setup method of the specified RMath channel (the specified channel when real time math is turned on).	4-23
:CHANnel<x>:RMATh:VDIV	Sets or queries the value/div setting of the specified RMath channel (the specified channel when real time math is turned on).	4-23
:CHANnel<x>:RMATh:ZOOM	Sets or queries the vertical zoom factor of the specified RMath channel (the specified channel when real time math is turned on).	4-23

RMATh CHANnel Group

The commands in this group deal with real time math. You can perform the same operations and make the same settings and queries that you can make from the Filter/Delay Setup menu that you access by pressing a key from CH1 to CH16 on the front panel or by accessing the menus for channels RMATh1 to RMATh16.

:CHANnel<x1>:RMATh:ATANgent:SCALe

Function Sets or queries the scale of the specified channel's arc tangent operation.

Syntax
```
:CHANnel<x>:RMATh:ATANgent:
SCALe {DEGRee|RADian}
:CHANnel<x>:RMATh:ATANgent:SCALe?
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:ATANGENT:
SCALE DEGREE
:CHANNEL1:RMATH:ATANGENT:SCALE?
-> :CHANNEL1:RMATH:ATANGENT:
   SCALE DEGREE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ATANgent:QUADrant

Function Sets or queries the quadrant range for the arctangent calculation of the specified channel.

Example
```
:CHANnel<x>:RMATh:ATANgent:
QUADrant {2|4}
:CHANnel<x>:RMATh:ATANgent:QUADrant?
<x> = 1 to 16
```

Example
```
:CHANNEL:RMATH:ATANGENT:QUADRANT 2
:CHANNEL:RMATH:ATANGENT:QUADRANT?
-> :CHANNEL:RMATH:ATANGENT:
   QUADRANT 2
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:AVALue

Function Sets or queries coefficient A of the currently specified real time math operation.

Syntax
```
:CHANnel<x>:RMATh:AVALue {<NRf>}
:CHANnel<x>:RMATh:AVALue?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
CHANNEL1:RMATH:AVALUE +1.0000E+30
CHANNEL1:RMATH:AVALUE?
-> CHANNEL1:RMATH:AVALUE+ 1.0000E+30
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:BVALue

Function Sets or queries coefficient B of the currently specified real time math operation.

Syntax
```
:CHANnel<x>:RMATh:BVALue {<NRf>}
:CHANnel<x>:RMATh:BVALue?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
CHANNEL1:RMATH:BVALUE +1.0000E+30
CHANNEL1:RMATH:BVALUE?
-> CHANNEL1:RMATH:BVALUE +1.0000E+30
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:BWIDth:BAND

Function Sets or queries the band of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
BAND {BPASs|HPASs|LPASs}
:CHANnel<x>:RMATh:BWIDth:BAND?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:BWIDTH:BAND BPASS
:CHANNEL1:RMATH:BWIDTH:BAND?
-> :CHANNEL1:RMATH:BWIDTH:BAND BPASS
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.
- When the digital filter type is "GAUSs," you can only select LPASs.

:CHANnel<x>:RMATh:BWIDth:CFRequency

Function Sets or queries the center frequency of the bandpass filter of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
CFRequency {<Frequency>}
:CHANnel<x>:RMATh:BWIDth:CFRequency?
<x> = 1 to 16
```
<Frequency>:

When TYPE is set to IIR

	60Hz to 300kHz
Resolution	20Hz (60Hz to 1.18kHz)
	200Hz (1.2kHz to 11.8kHz)
	2kHz (12kHz to 294kHz)

When TYPE is set to SHARp

	300Hz to 300kHz
Resolution	20Hz (300Hz to 2.98kHz)
	200Hz (3kHz to 29.8kHz)
	2kHz (30kHz to 290kHz)

Example
```
:CHANNEL1:RMATH:BWIDTH:
CFREQUENCY 300Hz
:CHANNEL1:RMATH:BWIDTH:
CFREQUENCY?
-> :CHANNEL1:RMATH:BWIDTH:
   CFREQUENCY 300Hz
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:BWIDth:CUToff

Function Sets or queries the cutoff frequency of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
{CUToff|<Frequency>}
:CHANnel<x>:RMATh:BWIDth:CUToff?
<x> = 1 to 16
<Frequency>:
```
When TYPE is set to GAUSs or when TYPE is set to SHARp and BAND is set to LPASs

	2Hz to 300kHz
Resolution	0.2Hz (2Hz to 29.8Hz)
	2Hz (30Hz to 298Hz)
	20Hz (300Hz to 2.98kHz)
	200Hz (3kHz to 29.8kHz)
	2kHz (30kHz to 300kHz)

When TYPE is set to SHARp and BAND is set to HPASs

	200Hz to 300kHz
Resolution	20Hz (200Hz to 2.98kHz)
	200Hz (3kHz to 29.8kHz)
	2kHz (30kHz to 300kHz)

When TYPE is set to IIR and BAND is set to LPASs

	2Hz to 300kHz
Resolution	2Hz (2Hz to 298Hz)
	20Hz (300Hz to 2.98kHz)
	200Hz (3kHz to 29.8kHz)
	2kHz (30kHz to 300kHz)

When TYPE is set to IIR and BAND is set to HPASs

	20Hz to 300kHz
Resolution	20Hz (20Hz to 2.98kHz)
	200Hz (3kHz to 29.8kHz)
	2kHz (30kHz to 300kHz)

Example
```
:CHANNEL1:RMATH:BWIDTH:CUTOFF 300kHz
:CHANNEL1:RMATH:BWIDTH:CUTOFF?
-> :CHANNEL1:RMATH:BWIDTH:
   CUTOFF 300kHz
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.
- When the digital filter type is "GAUSs," you can only select LPASs.

:CHANnel<x>:RMATh:BWIDth:INTerpo

Function Sets or queries the interpolation function of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
INTerpo {<Boolean>}
:CHANnel<x>:RMATh:BWIDth:INTerpo?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:BWIDTH:INTERPO 1
:CHANNEL1:RMATH:BWIDTH:INTERPO?
-> :CHANNEL1:RMATH:BWIDTH:INTERPO 1
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:BWIDth:MEAN?

Function Queries all mean settings of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:MEAN?
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:BWIDth:MEAN:SAMPle (Base Sample)

Function Sets or queries the sample of the mean of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:MEAN:
SAMPle<Frequency>
:CHANnel<x>:RMATh:BWIDth:MEAN:
SAMPle?
<x> = 1 to 16
<Frequency>: 1MHz, 100kHz, 10kHz,
             1kHz
```

Example
```
:CHANNEL1:RMATH:BWIDTH:MEAN:
SAMPLE 1MHz
:CHANNEL1:RMATH:BWIDTH:MEAN:SAMPLE?
-> :CHANNEL1:RMATH:BWIDTH:MEAN:
   SAMPLE 1MHz
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH Voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:BWIDth:MEAN:TAP

Function Sets or queries the taps of the mean of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:MEAN:
TAP {<NRf>}
:CHANnel<x>:RMATh:BWIDth:MEAN:TAP?
<x> = 1 to 16
<NRf> = 2, 4, 8, 16, 32, 64, 128
```

Example
```
:CHANNEL1:RMATH:BWIDTH:MEAN:TAP 4
:CHANNEL1:RMATH:BWIDTH:MEAN:TAP?
-> :CHANNEL1:RMATH:BWIDTH:MEAN:TAP 4
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:BWIDth:MODE

Function Sets or queries the filter mode of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
MODE {LPF|DIGital}
:CHANnel<x>:RMATh:BWIDth:MODE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:BWIDTH:MODE LPF
:CHANNEL1:RMATH:BWIDTH:MODE
-> :CHANNEL1:RMATH:BWIDTH:MODE LPF
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:BWIDth:PBANd (Pass Band)

Function Sets or queries the bandwidth of the bandpass filter of the specified channel's digital filter.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
PBANd {<Frequency>}
:CHANnel<x>:RMATh:BWIDth:PBANd?
<x> = 1 to 16
<Frequency>:
  When TYPE is set to IIR
    200kHz, 150kHz, 100kHz, 50kHz,
    20kHz, 15kHz, 10kHz, 5kHz, 2kHz,
    1.5kHz, 1kHz, 500Hz, 200Hz, 100Hz
  When TYPE is set to SHARp
    200kHz, 150kHz, 100kHz, 50kHz,
    20kHz, 15kHz, 10kHz, 5kHz, 2kHz,
    1.5kHz, 1kHz, 500Hz, 200Hz
```

Example
```
:CHANNEL1:RMATH:BWIDTH:PBAND 200Hz
:CHANNEL1:RMATH:BWIDTH:PBAND?
-> :CHANNEL1:RMATH:BWIDTH:
   PBAND 200Hz
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.
- When the center frequency is changed, if the frequency approaches the bandwidth limit, the bandwidth is changed.

:CHANnel<x>:RMATh:BWIDth:TYPE

Function Sets or queries the digital filter type of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:BWIDth:
TYPE {GAUSs|IIR|SHARp|MEAN}
:CHANnel<x>:RMATh:BWIDth:TYPE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:BWIDTH:TYPE IIR
:CHANNEL1:RMATH:BWIDTH:TYPE?
-> :CHANNEL1:RMATH:BWIDTH:TYPE IIR
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:CANId:BRATe (Bit Rate)

Function Sets or queries the CAN ID bit rate of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:CANId:
BRATe {<NRf>}
:CHANnel<x>:RMATh:CANId:BRATe?
<x> = 1 to 16
<NRf> = 10000, 20000, 33300, 50000,
        62500, 66700, 83300, 100000,
        125000, 250000, 500000,
        800000, 1000000
```

Example
```
:CHANNEL:RMATH:CANID:BRATE 500000
:CHANNEL:RMATH:CANID:BRATE?
-> :CHANNEL:RMATH:CANID:BRATE 500000
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:CANId:MFORmat (Message Format)

Function Sets or queries the CAN ID message format of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:CANId:
MFORmat {STANDard|EXTended}
:CHANnel<x>:RMATh: CANId:MFORmat?
<x> = 1 to 16
```

Example
```
:CHANNEL:RMATH:CANID:MFORMAT STANDARD
:CHANNEL:RMATH:CANID:MFORMAT?
-> :CHANNEL:RMATH:CANID:
   MFORMAT STANDARD
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:CANId:MID (Message ID)

Function Sets or queries the CAN ID message ID of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:CANId:
MID {<String>}
:CHANnel<x>:RMATh:CANId:MID?
<x> = 1 to 16
```
- When MFormat is set to Standard
  <String> = "0" to "7FF"
- When MFormat is set to Extended
  <String> = "0" to "1FFFFFFF"

Example
```
:CHANNEL:RMATH:CANID:MID "7FF"
:CHANNEL:RMATH:CANID:MID?
-> :CHANNEL:RMATH:CANID:MID "7FF"
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:CANId:SOURce

Function Sets or queries the CAN ID detection source waveform of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:CANId:
SOURce {<NRf>}
:CHANnel<x>:RMATh:CANId:SOURce?
<x> = 1 to 16
<NRf> = 1 to 16
```

Example
```
:CHANNEL:RMATH:CANID:SOURCE 1
:CHANNEL:RMATH:CANID:SOURCE?
-> :CHANNEL:RMATH:CANID:SOURCE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:CVALue

Function Sets or queries coefficient C of the currently specified real time math operation.

Syntax
```
:CHANnel<x>:RMATh:CVALue {<NRf>}
:CHANnel<x>:RMATh:CVALue?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
CHANNEL1:RMATH:CVALUE +1.0000E+30
CHANNEL1:RMATH:CVALUE?
-> CHANNEL1:RMATH:CVALUE +1.0000E+30
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:DA?

Function Queries all logic signal to analog waveform conversion settings.

Syntax
```
:CHANnel<x>:RMATh:DA?
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x>:RMATh:DA:BLENgth (Bit Length)

Function Sets or queries the logic signal to analog waveform conversion bit length.

Syntax
```
:CHANnel<x>:RMATh:DA:BLENgth {<NRf>}
:CHANnel<x>:RMATh:DA:BLENgth?
<x> = 2 to 16
<NRf> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:DA:BLENGTH 16
:CHANNEL1:RMATH:DA:BLENGTH?
-> :CHANNEL1:RMATH:DA:BLENGTH 16
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x1>:RMATh:DA:SOURce<x2>

Function Sets or queries the math source waveform that you want to convert into an analog waveform.

Syntax
```
:CHANnel<x>:RMATh:DA:
SOURce<x2> {<NRf>}
:CHANnel<x>:RMATh:DA:SOURce<x2>?
<x1> = 1 to 16
<x2> = 1, 2
```

Example
```
:CHANNEL1:RMATH:DA:SOURCE1 1
:CHANNEL1:RMATH:DA:SOURCE1?
-> :CHANNEL1:RMATH:DA:SOURCE1 1
```

Description
- This command is valid on models with the /G3 option.
- You cannot select logic channels of an installed CAN bus monitor module or CAN & LIN bus monitor module.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x>:RMATh:DA:TYPE

Function Sets or queries the logic signal to analog waveform conversion method (type).

Syntax
```
:CHANnel<x>:RMATh:DA:TYPE {OBINary|SIGNed|UNSigned}
:CHANnel<x>:RMATh:DA:TYPE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:DA:TYPE OBINARY
:CHANNEL1:RMATH:DA:TYPE?
-> :CHANNEL1:RMATH:DA:TYPE OBINARY
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x>:RMATh:DELay

Function Sets or queries the delay of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:DELay {<Time>}
:CHANnel<x>:RMATh:DELay?
<x> = 1 to 16
<NRf> = 0 s, 0.1 us to 10 ms
Resolution   0.1us to 100.0us: 0.1us
             101us to 1ms: 1us
             1.01ms to 10ms: 10us
```

Example
```
:CHANNEL1:RMATH:DELAY 0
:CHANNEL1:RMATH:DELAY?
-> :CHANNEL1:RMATH:DELAY 0
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, logic input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:DVALue

Function Sets or queries coefficient D of the currently specified real time math operation.

Syntax
```
:CHANnel<x>:RMATh:DVALue {<NRf>}
:CHANnel<x>:RMATh:DVALue?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
CHANNEL1:RMATH:DVALUE +1.0000E+30
CHANNEL1:RMATH:DVALUE?
-> CHANNEL1:RMATH:DVALUE +1.0000E+30
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ECOunt? (Edge Count)

Function Queries all reset condition settings for the specified channel's edge count operation.

Syntax
```
:CHANnel<x>:RMATh:ECOunt?
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ECOunt:MRESet:EXECute (Manual Reset)

Function Resets the counter of the specified channel's edge count operation.

Syntax
```
:CHANnel<x>:RMATh:ECOunt:MRESet:EXECute
```

Example
```
:CHANNEL1:RMATH:ECOUNT:MRESET:EXECUTE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ECOunt:OVERange

Function Sets or queries whether the edge count is reset when an over limit occurs for the specified channel's edge count operation.

Syntax
```
:CHANnel<x>:RMATh:ECOunt:OVERange {<Boolean>}
:CHANnel<x>:RMATh:ECOunt:OVERange?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:ECOUNT:OVERANGE 1
:CHANNEL1:RMATH:ECOUNT:OVERANGE?
-> :CHANNEL1:RMATH:ECOUNT:OVERANGE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ECOunt:SRESet (Start Reset)

Function Sets or queries whether the edge count is reset when the edge count operation starts for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:ECOunt:SRESet {<Boolean>}
:CHANnel<x>:RMATh:ECOunt:SRESet?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:ECOUNT:SRESET 1
:CHANNEL1:RMATH:ECOUNT:SRESET?
-> :CHANNEL1:RMATH:ECOUNT:SRESET 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:EVALue

Function Sets or queries coefficient E of the currently specified real time math operation.

Syntax
```
:CHANnel<x>:RMATh:EVALue {<NRf>}
:CHANnel<x>:RMATh:EVALue?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
CHANNEL1:RMATH:EVALUE +1.0000E+30
CHANNEL1:RMATH:EVALUE?
-> CHANNEL1:RMATH:EVALUE +1.0000E+30
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ?

Function Queries all the settings for the specified channel's frequency, period, and edge count (excluding reset) operations.

Syntax
```
:CHANnel<x>:RMATh:FREQ?
```

Description
- This command is valid on models with the /G3 option.
- To set the math settings for the frequency, period, and edge count (excluding reset) operations, use the :CHANnel<x>:RMATh:FREQ command and the commands that are lower in its hierarchy. Before you set any of the settings, use the :CHANnel<x>:RMATh:OPERation command to set the operation type to FREQuency, PERiod, or ECOunt. For details on the commands that have different settings for the various operations, see the conditions that are written in the command descriptions.

:CHANnel<x>:RMATh:FREQ:BIT

Function Sets or queries the math source waveform (the source bit) for the specified channel's frequency, period, and edge count operations (when the source is a logic channel).

Syntax
```
:CHANnel<x>:RMATh:FREQ:BIT {<NRf>}
:CHANnel<x>:RMATh:FREQ:BIT?
<x> = 1 to 16
<NRf> = 1 to 8
```

Example
```
:CHANNEL1:RMATH:FREQ:BIT 1
:CHANNEL1:RMATH:FREQ:BIT?
-> :CHANNEL1:RMATH:FREQ:BIT 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:DECeleration

Function Sets or queries whether frequency and period computation's deceleration prediction is turned on.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
DECeleration {<Boolean>}
:CHANnel<x>:RMATh:FREQ:DECeleration?
<x>=1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:DECELERATION ON
:CHANNEL1:RMATH:FREQ:DECELERATION? ->
:CHANNEL1:RMATH:FREQ:
DECELERATION ON
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:HYSTeresis

Function Sets or queries the detection hysteresis for the specified channel's frequency, period, and edge count operations.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
HYSTeresis {HIGH|LOW|MIDDLE}
:CHANnel<x>:RMATh:FREQ:HYSTeresis?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:HYSTERESIS HIGH
:CHANNEL1:RMATH:FREQ:HYSTERESIS?
-> :CHANNEL1:RMATH:FREQ:
   HYSTERESIS HIGH
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:LEVel

Function Sets or queries the detection level for the specified channel's frequency, period, and edge count operations.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
LEVel {<Voltage>|<NRf>|<Current>}
:CHANnel<x>:RMATh:FREQ:LEVel?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:LEVEL 1
:CHANNEL1:RMATH:FREQ:LEVEL?
-> :CHANNEL1:RMATH:FREQ:
   LEVEL 1.000000E+00
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:SCALe

Function Sets or queries the scale of the specified channel's frequency operation.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
SCALe {HZ|RPM}
:CHANnel<x>:RMATh:FREQ:SCALe?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:SCALE HZ
:CHANNEL1:RMATH:FREQ:SCALE?
-> :CHANNEL1:RMATH:FREQ:SCALE HZ
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:SLOPe

Function Sets or queries the detection slope for the specified channel's frequency, period, and edge count operations.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
SLOPe {RISE|FALL}
:CHANnel<x>:RMATh:FREQ:SLOPe?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:SLOPE RISE
:CHANNEL1:RMATH:FREQ:SLOPE?
-> :CHANNEL1:RMATH:FREQ:SLOPE RISE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:SOURce

Function Sets or queries the math source waveform for the specified channel's frequency, period, and edge count operations.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
SOURce {<NRf>[,<NRf>]}
:CHANnel<x>:RMATh:FREQ:SOURce?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:FREQ:SOURCE 1
:CHANNEL1:RMATH:FREQ:SOURCE?
-> :CHANNEL1:RMATH:FREQ:SOURCE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:FREQ:STOPpredict

Function Sets or queries whether frequency and period computation's stop prediction is turned on.

Syntax
```
:CHANnel<x>:RMATh:FREQ:
STOPpredict {<NRf>|OFF}
:CHANnel<x>:RMATh:FREQ:STOPpredict?
<x>=1 to 16
<NRf> = 2, 4, 8, 16
```

Example
```
:CHANNEL1:RMATH:FREQ:STOPPREDICT OFF
:CHANNEL1:RMATH:FREQ:STOPPREDICT?
-> :CHANNEL1:RMATH:FREQ:
   STOPPREDICT OFF
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter?

Function Queries all IIR filter operation settings.

Syntax
```
:CHANnel<x1>:RMATh:IFILter?
<x1> = 1 to 16
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter:BAND

Function Sets or queries the band of the IIR filter operation.

Syntax
```
:CHANnel<x1>:RMATh:IFILter:
BAND {BPASs|HPASs|LPASs}
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:IFILTER:BAND BPASS
:CHANNEL1:RMATH:IFILTER:BAND?
-> :CHANNEL1:RMATH:IFILTER:
   BAND BPASS
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter:CUToff

Function Sets or queries the cutoff frequency of the IIR filter operation.

Syntax
```
:CHANnel<x1>:RMATh:IFILter:
CUToff {<Frequency>}
<x1> = 1 to 16
<Frequency>:
When BAND is set to LPASs
      Range: 0.2 Hz to 3 MHz
      Resolution:
          0.2 Hz (0.2 Hz to 29.8 Hz)
          2 Hz (30 Hz to 298 Hz)
          20 Hz (300 Hz to 2.98 kHz)
          200 Hz (3 kHz to 29.8 kHz)
          2 kHz (30 kHz to 298 kHz)
          20 kHz (300 kHz to 3 MHz)
When BAND is set to HPASs
      Range: 20 Hz to 3 MHz
      Resolution:
          20 Hz (20 Hz to 2.98 kHz)
          200 Hz (3 kHz to 29.8 kHz)
          2 kHz (30 kHz to 298 kHz)
          20 kHz (300 kHz to 3 MHz)
```

Example
```
:CHANNEL1:RMATH:IFILTER:CUTOFF 100Hz
:CHANNEL1:RMATH:IFILTER:CUTOFF?
-> :CHANNEL1:RMATH:IFILTER:
   CUTOFF 100Hz
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter:CFRequency

Function Sets or queries the center frequency of the bandpass filter of the IIR filter operation.

Syntax
```
:CHANnel<x1>:RMATh:IFILter:
CFRequency {<Frequency>}
<x1> = 1 to 16
<Frequency>:
      Range: 60 Hz to 3 MHz
      Resolution:
         20 Hz (60 Hz to 1.18 kHz)
         200 Hz (1.2 kHz to 11.8 kHz)
         2 kHz (12 kHz to 118 kHz)
         20 kHz (120 kHz to 3 MHz)
```

Example
```
:CHANNEL1:RMATH:IFILTER:
CFREQUENCY 100Hz
:CHANNEL1:RMATH:IFILTER:CFREQUENCY?
-> :CHANNEL1:RMATH:IFILTER:
   CFREQUENCY 100Hz
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter:PBANd

Function Sets or queries the bandwidth of the bandpass filter of the IIR filter operation.

Syntax
```
:CHANnel<x1>:RMATh:IFILter:
PBANd {<Frequency>}
<x1> = 1 to 16
<Frequency> = 2 MHz, 1.5 MHz, 1 MHz,
500 kHz, 200 kHz, 150 kHz, 100 kHz,
50 kHz, 20 kHz, 15 kHz, 10 kHz,
5 kHz, 2 kHz, 1.5 kHz, 1 kHz,
500 Hz, 200 Hz, 100 Hz
```

Example
```
:CHANNEL1:RMATH:IFILTER:PBAND 100Hz
:CHANNEL1:RMATH:IFILTER:PBAND?
-> :CHANNEL1:RMATH:IFILTER:
   PBAND 100Hz
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:IFILter:INTerpo

Function Sets or queries whether interpolation is used with the IIR filter operation.

Syntax
```
:CHANnel<x1>:RMATh:IFILter:
INTerpo {<Boolean>}
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:IFILTER:INTERPO ON
:CHANNEL1:RMATH:IFILTER:INTERPO?
-> :CHANNEL1:RMATH:IFILTER:
   INTERPO ON
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral?

Function Queries all integration settings of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral?
<x> = 1 to 16
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:MRESet:EXECute (Manual Reset)

Function Resets the integrated value of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:MRESet:
EXECute
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:MRESET:
EXECUTE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:OVERange

Function Sets or queries whether the integrated value is reset when an over limit occurs for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:
OVERange {<Boolean>}
:CHANnel<x>:RMATh:INTegral:OVERange?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:OVERRANGE 1
:CHANNEL1:RMATH:INTEGRAL:OVERRANGE?
-> :CHANNEL1:RMATH:INTEGRAL:
   OVERRANGE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:SRESet (Start Reset)

Function Sets or queries whether the integrated value is reset when integration starts for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:
SRESet {<Boolean>}
:CHANnel<x>:RMATh:INTegral:SRESet?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:SRESET 1
:CHANNEL1:RMATH:INTEGRAL:SRESET?
-> :CHANNEL1:RMATH:INTEGRAL:SRESET 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:ZRESet?

Function Queries all settings related to the integrated value being reset when the signal crosses zero in integration of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:ZRESet?
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:ZRESet:HYSTeresis

Function Sets or queries the hysteresis that is used for resetting the integrated value when the signal crosses zero for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:ZRESet:
HYSTeresis {LOW|HIGH|MIDDle}
:CHANnel<x>:RMATh:INTegral:ZRESet:
HYSTeresis?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:ZRESET LOW
:CHANNEL1:RMATH:INTEGRAL:ZRESET?
-> :CHANNEL1:RMATH:INTEGRAL:
   ZRESET LOW
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:ZRESet:MODE

Function Sets or queries whether the integrated value is reset when the signal crosses zero for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:ZRESet:
MODE {<Boolean>}
:CHANnel<x>:RMATh:INTegral:ZRESet:
MODE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:ZRESET:
MODE 1
:CHANNEL1:RMATH:INTEGRAL:ZRESET:
MODE?
-> :CHANNEL1:RMATH:INTEGRAL:ZRESET:
   MODE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:INTegral:ZRESet:SLOPe

Function Sets or queries the slope that is used for resetting the integrated value when the signal crosses zero for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:INTegral:ZRESet:
SLOPe {FALL|RISE}
:CHANnel<x>:RMATh:INTegral:ZRESet:
SLOPe?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:INTEGRAL:ZRESET:
SLOPE FALL
:CHANNEL1:RMATH:INTEGRAL:ZRESET:
SLOPE?
-> :CHANNEL1:RMATH:INTEGRAL:ZRESET:
   SLOPE FALL
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:KNOCkflt?

Function Queries all knocking filter settings of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:KNOCkflt?
```

Description This command is valid on DL850Vs with the /G3 option.

:CHANnel<x>:RMATh:KNOCkflt:DIFFerential

Function Sets or queries the differentiation on/off status of the specified channel's knocking filter.

Syntax
```
:CHANnel<x>:RMATh:KNOCkflt:
DIFFerential {<Boolean>}
:CHANnel<x>:RMATh:KNOCkflt:
DIFFerential?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:KNOCKFLT:
DIFFERENTIAL 1
:CHANNEL1:RMATH:KNOCKFLT:
DIFFERENTIAL?
-> :CHANNEL1:RMATH:KNOCKFLT:
   DIFFERENTIAL 1
```

Description This command is valid on DL850Vs with the /G3 option.

:CHANnel<x>:RMATh:KNOCkflt:ELEVel

Function Sets or queries the elimination level of the specified channel's knocking filter.

Syntax
```
:CHANnel<x>:RMATh:KNOCkflt:
ELEVel {<Voltage>|<Current>|<NRf>}
:CHANnel<x>:RMATh:KNOCkfltinaiton:
ELEVel?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:KNOCKFLT:ELEVEL 1
:CHANNEL1:RMATH:KNOCKFLT:ELEVEL?
-> :CHANNEL1:RMATH:KNOCKFLT:
   ELEVEL 1.000000E+00
```

Description This command is valid on DL850Vs with the /G3 option.

:CHANnel<x>:RMATh:LABel

Function Sets or queries the label of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:LABel {<String>}
<x> = 1 to 16
<String> = Up to 16 characters
```

Example
```
:CHANNEL1:RMATH:LABEL" TRACE3"
:CHANNEL1:RMATH:LABEL?
-> :CHANNEL1:RMATH:LABEL" TRACE3"
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:MAVG (Moving Average)

Function Sets or queries the on/off status of the mean of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:MAVG {<Boolean>}
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:MAVG 1
:CHANNEL1:RMATH:MAVG?
-> :CHANNEL1:RMATH:MAVG 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:MODE

Function Sets or queries the real time math on/off status of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:MODE {<Boolean>}
:CHANnel<x>:RMATh:MODE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:MODE 1
:CHANNEL1:RMATH:MODE?
-> :CHANNEL1:RMATH:MODE 1
```

Description
- This command is valid on models with the /G3 option.
- You cannot set this setting to ON for the channels of an installed 16-CH voltage input module, 16-CH temperature/voltage input module, CAN bus monitor module, or CAN & LIN bus monitor module.

:CHANnel<x>:RMATh:OFFSet

Function Sets or queries the offset of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:OFFSet {<NRf>}
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:OFFSET 1
:CHANNEL1:RMATH:OFFSET?
-> :CHANNEL1:RMATH:OFFSET 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:OPERation

Function Sets or queries the operation of the specified real time math channel.

Syntax
```
:CHANnel<x>:RMATh:OPERation {PLUS|
MINus|MULTiple|DIVide|DIFFerential|
FPLus|FMINus|FMULtiple|FDIVide|INT1|
INT2|POLYnomial|SQRT1|SQRT2|LOG1|
LOG2|RANGle|SIN|COS|ATAN|RMS|POWer|
PINTegral|DA|KNOCkflt|ERANGle|PASub|
FREQuency|PERiod|ECOunt|RESolver|
IFILter|PWM|RPOWer|CANId}
:CHANnel<x>:RMATh:OPERation?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:OPERATION PLUS
:CHANNEL1:RMATH:OPERATION?
-> :CHANNEL1:RMATH:OPERATION PLUS
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:OPTimize

Function Optimizes the vertical scale of the specified channel that will be used in real time math.

Syntax
```
:CHANnel<x>:RMATh:OPTimize
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:OPTIMIZE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:PASub:SIGN

Function Sets or queries the signs of the sources for the polynomial with a coefficient operation of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:PASub:SIGN {MINus|
PLUS}[,{MINus|PLUS}][,{MINus|
PLUS}][,{MINus|PLUS}]
:CHANnel<x>:RMATh:PASub:SIGN?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:PASUB:SIGN PLUS
:CHANNEL1:RMATH:PASUB:SIGN?
-> :CHANNEL1:RMATH:PASUB:SIGN PLUS
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:PINTegral?

Function Queries all effective power integration settings of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:PINTegral?
```

:CHANnel<x>:RMATh:PINTegral:MRESet:EXECute

Function Resets the effective power integration of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:PINTegral:MRESet:
EXECute
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:PINTEGRAL:MRESET:
EXECUTE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:PINTegral:OVERange

Function Sets or queries whether the integrated power value of the specified channel is reset when an over limit occurs during effective power integration.

Syntax
```
:CHANnel<x>:RMATh:PINTegral:
OVERange {<Boolean>}
:CHANnel<x>:RMATh:PINTegral:
OVERange?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:PINTEGRAL:
OVERRANGE 1
:CHANNEL1:RMATH:PINTEGRAL:OVERRANGE?
-> :CHANNEL1:RMATH:PINTEGRAL:
   OVERRANGE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:PINTegral:SCALe

Function Sets the reference time for the effective power integration of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:PINTegral:
SCALe {HOUR|SECond}
:CHANnel<x>:RMATh:PINTegral:SCALe?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:PINTEGRAL:SCALE HOUR
:CHANNEL1:RMATH:PINTEGRAL:SCALE
-> :CHANNEL1:RMATH:PINTEGRAL:
   SCALE HOUR
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:PINTegral:SRESet

Function Sets or queries whether the integrated value is reset when the effective power integration starts for the specified channel.

Syntax
```
:CHANnel<x>:RMATh:PINTegral:
SRESet {<Boolean>}
:CHANnel<x>:RMATh:PINTegral:SRESet?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:PINTEGRAL:SRESET 1
:CHANNEL1:RMATH:PINTEGRAL:SRESET?
-> :CHANNEL1:RMATH:PINTEGRAL:
   SRESET 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:POSition

Function Sets or queries the vertical position of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:POSition {<NRf>}
:CHANnel<x>:RMATh:POSition?
<x> = 1 to 16
<NRf> = −5.00 to +5.00 (div; in
      steps of 0.01 div)
```

Example
```
:CHANNEL1:RMATH:POSITION 2.00
:CHANNEL1:RMATH:POSITION?
-> :CHANNEL1:RMATH:POSITION 2.00
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:POWer?

Function Queries all effective power calculation period settings of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:POWer?
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:POWer:TERM:EBIT

Function Sets or queries the effective power calculation period's edge detection math source waveform (detection bit) of the specified channel (when a logic channel is being used as the edge detection channel).

Syntax
```
:CHANnel<x>:RMATh:POWer:TERM:
EBIT {<NRf>}
:CHANnel<x>:RMATh:POWer:TERM:EBIT?
<x> = 1 to 16
<NRf> = 1 to 8
```

Example
```
:CHANNEL1:RMATH:POWER:TERM:EBIT 1
:CHANNEL1:RMATH:POWER:TERM:EBIT?
-> :CHANNEL1:RMATH:POWER:TERM:EBIT 1
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:RMS command.

:CHANnel<x>:RMATh:POWer:TERM:EHYSteresis

Function Sets or queries the effective power calculation period's detection hysteresis of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:POWer:TERM:
EHYSteresis {HIGH|LOW|MIDDle}
:CHANnel<x>:RMATh:POWer:TERM:
EHYSteresis?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:POWER:TERM:
EHYSTERESIS HIGH
:CHANNEL1:RMATH:POWER:TERM:
EHYSTERESIS?
-> :CHANNEL1:RMATH:POWER:TERM:
   EHYSTERESIS HIGH
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:RMS command.

:CHANnel<x>:RMATh:POWer:TERM:ELEVel

Function Sets or queries the effective power calculation period's detection level of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:POWer:TERM:
ELEVel {<Voltage>|<NRf>|<Current>}
:CHANnel<x>:RMATh:POWer:TERM:ELEVel?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:POWER:TERM:ELEVEL 1
:CHANNEL1:RMATH:POWER:TERM:ELEVEL? ->
:CHANNEL1:RMATH:POWER:TERM:
ELEVEL 1.000000E+00
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:RMS command.

:CHANnel<x>:RMATh:POWer:TERM:ESLope

Function Sets or queries the effective power calculation period's detection slope of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:POWer:TERM:
ESLope {BISlope|FALL|RISE}
:CHANnel<x>:RMATh:POWer:TERM:ESLope?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:POWER:TERM:
ESLOPE FALL
:CHANNEL1:RMATH:POWER:TERM:ESLOPE?
-> :CHANNEL1:RMATH:POWER:TERM:
   ESLOPE FALL
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:RMS command.

:CHANnel<x>:RMATh:POWer:TERM:ESOurce

Function Sets or queries the effective power calculation period's edge detection math source waveform of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:POWer:
ESOurce {S1|S2|<NRf>[,<NRf>]}
:CHANnel<x>:RMATh:POWer:ESOurce?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:POWER:TERM:
ESOURCE S1
:CHANNEL1:RMATH:POWER:TERM:ESOURCE?
-> :CHANNEL1:RMATH:POWER:TERM:
   ESOURCE S1
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:RMS command.

:CHANnel<x1>:RMATh:PWM:PERiod

Function Sets or queries the period of the PWM operation.

Syntax
```
:CHANnel<x1>:RMATh:PWM:
PERiod {<Time>}
<x1> = 1 to 16
<Time> = 0.0000001 to 0.005 s
(100 ns to 5 ms)
```

Example
```
:CHANNEL1:RMATH:PWM:PERIOD 0.01
:CHANNEL1:RMATH:PWM:PERIOD?
-> :CHANNEL1:RMATH:PWM:PERIOD 0.01
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle?

Function Queries all settings related to the angle-of-rotation, electrical angle, sine, and cosine operations of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:RANGle?
```

Description
- This command is valid on models with the /G3 option.
- To set the math settings for the angle-of-rotation, electrical angle, sine, and cosine operations, use the :CHANnel<x>:RMATh:RANGle command and the commands that are lower in its hierarchy. Before you set any of the settings, use the :CHANnel<x>:RMATh:OPERation command to set the operation type to RANGle, EANGle, SIN, or COS. For details on the commands that have different settings for the various operations, see the conditions that are written in the command descriptions.

:CHANnel<x>:RMATh:RANGle:BLENgth

Function Sets or queries the bit length when the encoding type is GRAY for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
BLENgth {<NRf>}
:CHANnel<x>:RMATh:RANGle:BLENgth?
<x>=1 to 16
<NRf>=2 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:BLENGTH 16
:CHANNEL1:RMATH:RANGLE:BLENGTH?
-> :CHANNEL1:RMATH:RANGLE:
   BLENGTH 16
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:CCONdition

Function Sets or queries the resolution for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
CCONdition {<NRf>}
:CHANnel<x>:RMATh:RANGle:CCONdition?
<x> = 1 to 16
<NRf> = 1, 2, 4
```

Example
```
:CHANNEL1:RMATH:RANGLE:CCONDITION 4
:CHANNEL1:RMATH:RANGLE:CCONDITION?
-> :CHANNEL1:RMATH:RANGLE:
   CCONDITION 4
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:ETYPe (Edge Type)

Function Sets or queries the encoding type for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
ETYPe {ABZ|AZ|A8Bit|A16Bit|GRAY|
RESolver}
:CHANnel<x>:RMATh:RANGle:ETYPe?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:ETYPE ABZ
:CHANNEL1:RMATH:RANGLE:ETYPE?
-> :CHANNEL1:RMATH:RANGLE:ETYPE ABZ
```

Description
- This command is valid on models with the /G3 option.
- RESolver is valid when the operation type (CHANnel<x>:RMATh:OPERation command) is set to ERANGe, SIN, or COS and when the operation type of another real time math channel is set to RESolver.

:CHANnel<x1>:RMATh:RANGle:HYSTeresis<x2>

Function Sets or queries the slope for the specified math source waveform for the specified channel' s angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
HYSTeresis<x2> {HIGH|LOW|MIDDle}
:CHANnel<x>:RMATh:RANGle:
HYSTeresis <x2>?
<x1> = 1 to 16
<x2> = 1 to 3
```

Example
```
:CHANNEL1:RMATH:RANGLE:
HYSTERESIS HIGH
:CHANNEL1:RMATH:RANGLE:HYSTERESIS? ->
:CHANNEL1:RMATH:RANGLE:
HYSTERESIS HIGH
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RANGle:LEVel<x2>

Function Sets or queries the detection level for the specified math source waveform for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
LEVel<x2> {<Voltage>|<NRf>|
<Current>}
:CHANnel<x>:RMATh:RANGle:LEVel<x2>?
<x1> = 1 to 16
<x2> = 1 to 3
```

Example
```
:CHANNEL1:RMATH:RANGLE:LEVEL 1
:CHANNEL1:RMATH:RANGLE:LEVEL?
-> :CHANNEL1:RMATH:RANGLE:
   LEVEL 1.000000E+00
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:LOGic?

Function Queries all the math source waveform settings for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:LOGic?
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x>:RMATh:RANGle:LOGic:MODE

Function Sets or queries the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:LOGic:
MODE {<Boolean>}
:CHANnel<x>:RMATh:RANGle:LOGic:MODE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:LOGIC:MODE 1
:CHANNEL1:RMATH:RANGLE:LOGIC:MODE?
-> :CHANNEL1:RMATH:RANGLE:LOGIC:
   MODE 1
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x1>:RMATh:RANGle:LOGic:SBIT<x2> (Source BIT)

Function Sets or queries the source bit when the math source waveform mode for the specified channel' s angle-of-rotation, electrical angle, sine, and cosine operations is logic.

Syntax
```
:CHANnel<x1>:RMATh:RANGle:LOGic:
SBIT<x2> {<NRf>}
:CHANnel<x1>:RMATh:RANGle:LOGic:
SBIT<x2>?
<x1> = 1 to 16
<x2> = 1 to 3
      1:     Phase A setting
      2:     Phase B setting
      3:     Phase Z setting
<NRf> = 1 to 8
```

Example
```
:CHANNEL1:RMATH:RANGLE:LOGIC:SBIT1 1
:CHANNEL1:RMATH:RANGLE:LOGIC:SBIT1?
-> :CHANNEL1:RMATH:RANGLE:LOGIC:
   SBIT1 1
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x1>:RMATh:RANGle:LOGic:SOURce<x2>

Function Sets or queries the math source waveform when the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations is logic.

Syntax
```
:CHANnel<x>:RMATh:RANGle:LOGic:
SOURce<x2> {<NRf>}
:CHANnel<x>:RMATh:RANGle:LOGic:
SOURce<x2>?
<x1> = 1 to 16, <x2> = 1 to 2
<NRf> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:LOGIC:
SOURCE1 1
:CHANNEL1:RMATH:RANGLE:LOGIC:
SOURCE1?
-> :CHANNEL1:RMATH:RANGLE:LOGIC:
   SOURCE1 1
```

Description
- This command is valid on models with the /G3 option.
- An execution error will occur if you specify a channel other than that of a logic input module.

:CHANnel<x1>:RMATh:RANGle:MRESet:EXECute

Function Resets the angle of the specified channel's angle operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:MRESet:
EXECute
<x1> = 1 to 16
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:PROTate (Pulse per Rotate)

Function Sets or queries the number of pulses per rotation for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
PROTate {<NRf>}
:CHANnel<x>:RMATh:RANGle:PROTate?
<x> = 1 to 16
<NRf> = 1 to 65535
```

Example
```
:CHANNEL1:RMATH:RANGLE:PROTATE 1
:CHANNEL1:RMATH:RANGLE:PROTATE?
-> :CHANNEL1:RMATH:RANGLE:PROTATE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:REVerse

Function Sets or queries whether the rotation direction is inverted for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
REVerse {<Boolean>}
:CHANnel<x>:RMATh:RANGle:REVerse?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:REVERSE 1
:CHANNEL1:RMATH:RANGLE:REVERSE? ->
:CHANNEL1:RMATH:RANGLE:REVERSE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RANGle:RSOurce (Resolver Source Ch)

Function Sets or queries the math source waveform when the encoding type of the angle-of-rotation, sine, and cosine operations is RESolver.

Syntax
```
:CHANnel<x1>:RMATh:RANGle:
RSOurce {RMATh<x2>}
<x1> = 1 to 16
<x2> = 1 to 15
```

Example
```
:CHANNEL1:RMATH:RANGLE:
RSOURCE RMATH1
:CHANNEL1:RMATH:RANGLE:RSOURCE?
-> :CHANNEL1:RMATH:RANGLE:
   RSOURCE RMATH1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RANGle:RTIMing (Reset Timing)

Function Sets or queries the timing that will be used to reset the number of rotations for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
RTIMing {ZTERm|ZARise|ZA1L|ZA2H|
ZA2L}
:CHANnel<x>:RMATh:RANGle:RTIMing?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:RTIMING ZTERM
:CHANNEL1:RMATH:RANGLE:RTIMING?
-> :CHANNEL1:RMATH:RANGLE:
   RTIMING ZTERM
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RANGle:SCALe

Function Sets or queries the scale of the specified channel's angle-of-rotation and electrical angle operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
SCALe {DEGRee|RADian|USERdefine}
:CHANnel<x>:RMATh:RANGle:SCALe?
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:SCALE DEGREE
:CHANNEL1:RMATH:RANGLE:SCALE?
-> :CHANNEL1:RMATH:RANGLE:
   SCALE DEGREE
```

Description
- This command is valid on models with the /G3 option.
- USERdefine can only be specified when the :CHANnel<x>:RMATh:OPERation command has been used to select RANGle.

:CHANnel<x>:RMATh:RANGle:SLOGic (Source Logic)

Function Sets or queries the math source waveform type for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
SLOGic {<Boolean>}
:CHANnel<x>:RMATh:RANGle:SLOGic?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:SLOGIC 1
:CHANNEL1:RMATH:RANGLE:SLOGIC? ->
:CHANNEL1:RMATH:RANGLE:SLOGIC 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RANGle:SOURce<x2>

Function Sets or queries the math source waveform when the math source waveform mode for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations is not logic.

Syntax
```
:CHANnel<x1>:RMATh:RANGle:
SOURce<x2> {<NRf>[,<NRf>]}
:CHANnel<x1>:RMATh:RANGle:
SOURce<x2>?
<x1> = 1 to 16
<x2> = 1 to 3
<NRf> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RANGLE:SOURCE1 1
:CHANNEL1:RMATH:RANGLE:SOURCE1?
-> :CHANNEL1:RMATH:RANGLE:SOURCE1 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RANGle:TIMing<x2> (Edge Timing)

Function Sets or queries the edge detection timing for the specified channel's angle-of-rotation, electrical angle, sine, and cosine operations.

Syntax
```
:CHANnel<x>:RMATh:RANGle:
TIMing {ARISe|S1Low|S2High|S2Low}
:CHANnel<x>:RMATh:RANGle:TIMing?
<x1> = 1 to 16
<x2> = 1, 2
```

Example
```
:CHANNEL1:RMATH:RANGLE:TIMING ARISE
:CHANNEL1:RMATH:RANGLE:TIMING?
-> :CHANNEL1:RMATH:RANGLE:
   TIMING ARISE
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver?

Function Queries all resolver operation settings.

Syntax
```
:CHANnel<x1>:RMATh:RESolver?
<x1> = 1 to 16
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver:SOURce<x2>

Function Sets or queries the math source waveform of the resolver operation.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
SOURce<x2> {<NRf>[,<NRf>]}
<x1> = 1 to 16
<x2> = 1 to 3
      1: Carrier channel (excitation
         waveform)
      2: sinθ channel
      3: cosθ channel
```

Example
```
:CHANNEL1:RMATH:RESOLVER:SOURCE1 1
:CHANNEL1:RMATH:RESOLVER:SOURCE1?
-> :CHANNEL1:RMATH:RESOLVER:
   SOURCE1 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver: SMODe(Sample Mode)

Function Sets or queries the sample mode of the resolver operation.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
SMODe {AUTO|MANual}
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RESOLVER:SMODE AUTO
:CHANNEL1:RMATH:RESOLVER:SMODE?
-> :CHANNEL1:RMATH:RESOLVER:
   SMODE AUTO
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver:HYSTeresis

Function Sets or queries the hysteresis of the resolver operation when the sample mode is set to AUTO.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
HYSTeresis {HIGH|LOW|MIDDle}
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RESOLVER:
HYSTERESIS LOW
:CHANNEL1:RMATH:RESOLVER:HYSTERESIS?
-> :CHANNEL1:RMATH:RESOLVER:
   HYSTERESIS LOW
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver: STIMe(Sampling Time)

Function Sets or queries the time from the excitation waveform edge of the resolver operation when the sample mode is set to MANual.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
STIMe {<Time>}
<x1> = 1 to 16
<Time> = 0.0000001 to 0.001 s
         (100 ns to 1 ms)
```

Example
```
:CHANNEL1:RMATH:RESOLVER:
STIME 0.0001
:CHANNEL1:RMATH:RESOLVER:STIME?
-> :CHANNEL1:RMATH:RESOLVER:
   STIME 1.0E-3
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver:TFILter

Function Sets or queries the tracking filter of the resolver operation.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
TFILter {OFF|<NRf>}
<x1> = 1 to 16
<NRf> = 100, 250, 1000, 2000
```

Example
```
:CHANNEL1:RMATH:RESOLVER:TFILTER 100
:CHANNEL1:RMATH:RESOLVER:TFILTER?
-> :CHANNEL1:RMATH:RESOLVER:
   TFILTER 100
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:RESolver:SCALe

Function Sets or queries the scale of the resolver operation.

Syntax
```
:CHANnel<x1>:RMATh:RESolver:
SCALe {DEG1|DEG2|RAD1|RAD2}
<x1> = 1 to 16
DEG1: Degrees (−180 to +180)
DEG2: Degrees (0 to +360)
RAD1: Radians (−π to π)
RAD2: Radians (0 to 2π)
```

Example
```
:CHANNEL1:RMATH:RESOLVER:SCALE DEG1
:CHANNEL1:RMATH:RESOLVER:SCALE?
-> :CHANNEL1:RMATH:RESOLVER:
   SCALE DEG1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RMS?

Function Queries all RMS calculation period settings of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:RMS?
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RMS:TERM:EBIT

Function Sets or queries the edge detection math source waveform (the detection bit) for when the RMS calculation period of the specified channel is set to edge (when a logic channel is being used as the edge detection channel).

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
EBIT {<NRf>}
:CHANnel<x>:RMATh:RMS:TERM:EBIT?
<x> = 1 to 16
<NRf> = 1 to 8
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:EBIT 1
:CHANNEL1:RMATH:RMS:TERM:EBIT?
-> :CHANNEL1:RMATH:RMS:TERM:EBIT 1
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>: RMATh:POWer command.

:CHANnel<x>:RMATh:RMS:TERM:EHYSteresis

Function Sets or queries the detection hysteresis for when the RMS calculation period of the specified channel is set to edge.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
EHYSteresis {HIGH|LOW|MIDDle}
:CHANnel<x>:RMATh:RMS:TERM:
EHYSteresis?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:
EHYSTERESIS HIGH
:CHANNEL1:RMATH:RMS:TERM:
EHYSTERESIS?
-> :CHANNEL1:RMATH:RMS:TERM:
   EHYSTERESIS HIGH
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:POWer command.

:CHANnel<x>:RMATh:RMS:TERM:ELEVel

Function Sets or queries the detection level for when the RMS calculation period of the specified channel is set to edge.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
ELEVel {<Voltage>|<NRf>|<Current>}
:CHANnel<x>:RMATh:RMS:TERM:ELEVel?
<x> = 1 to 16
```

Example
```
:CHANNEL:RMATH:RMS:TERM:ELEVEL 1
:CHANNEL1:RMATH:RMS:TERM:ELEVEL?
-> :CHANNEL1:RMATH:RMS:TERM:
   ELEVEL 1.000000E+00
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:POWer command.

:CHANnel<x>:RMATh:RMS:TERM:ESLope

Function Sets or queries the detection slope for when the RMS calculation period of the specified channel is set to edge.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
ESLope {BISLope|FALL|RISE}
:CHANnel<x>:RMATh:RMS:TERM:ESLope?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:ESLOPE FALL
:CHANNEL1:RMATH:RMS:TERM:ESLOPE?
-> :CHANNEL1:RMATH:RMS:TERM:
   ESLOPE FALL
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:POWer command.

:CHANnel<x>:RMATh:RMS:TERM:ESOurce

Function Sets or queries the edge detection math source waveform for when the RMS calculation period of the specified channel is set to edge.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
ESOurce {OWN|<NRf>[,<NRf>]|
RMATh<x2>}
:CHANnel<x>:RMATh:RMS:TERM:ESOurce?
<x> = 1 to 16
<x2> = 1 to 15
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:ESOURCE OWN
:CHANNEL1:RMATH:RMS:TERM:ESOURCE?
-> :CHANNEL1:RMATH:RMS:TERM:
   ESOURCE OWN
```

Description
- This command is valid on models with the /G3 option.
- This setting is shared with the :CHANnel<x>:RMATh:POWer command.

:CHANnel<x>:RMATh:RMS:TERM:MODE

Function Sets or queries the RMS calculation period mode of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
MODE {TIME|EDGE}
:CHANnel<x>:RMATh:RMS:TERM:MODE?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:MODE TIME
:CHANNEL1:RMATH:RMS:TERM:MODE?
-> :CHANNEL1:RMATH:RMS:TERM:
   MODE TIME
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RMS:TERM:TIME

Function Sets or queries the interval for when the RMS calculation period of the specified channel is set to time.

Syntax
```
:CHANnel<x>:RMATh:RMS:TERM:
TIME {<Time>}
:CHANnel<x>:RMATh:RMS:TERM:TIME?
<x> = 1 to 16
<Time> = 1ms to 500.0ms
```

Example
```
:CHANNEL1:RMATH:RMS:TERM:TIME 100ms
:CHANNEL1:RMATH:RMS:TERM:TIME?
-> :CHANNEL1:RMATH:RMS:TERM:
   TIME 100ms
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:RPOWer:SOURce<x2>

Function Sets or queries the apparent-power, effective-power, voltage, or current channel used to calculate the reactive power of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:RPOWer:
SOURce<x2> {<NRf>[,<NRf>]|RMATh<x3>}
:CHANnel<x>:RMATh:RPOWer:SOURce<x2>?
<x> = 1 to 16
<x2> = 1 to 4
  1: ApparentPower
  2: EffectivePower
  3: Voltage
  4: Current
<x3> = 1 to 15
```

Example
```
:CHANNEL:RMATH:RPOWER:SOURCE RMATH1
:CHANNEL:RMATH:RPOWER:SOURCE?
-> :CHANNEL:RMATH:RPOWER:
   SOURCE RMATH1
```

Description
- This command is valid on models with the /G3 option.
- You can also use the CHANnel<x>:RMATh:SC<x> command.

:CHANnel<x>:RMATh:RPOWer:VOLTage:HYSTeresis

Function Sets or queries the hysteresis of the voltage channel used to calculate the reactive power of the specified channel.

Syntax
```
:CHANnel<x>:RMATh:RPOWer:VOLTage:
HYSTeresis {HIGH|LOW|MIDDle}
:CHANnel<x>:RMATh:RPOWer:VOLTage:
HYSTeresis?
<x> = 1 to 16
```

Example
```
:CHANNEL:RMATH:RPOWER:VOLTAGE:
HYSTERESIS HIGH
:CHANNEL:RMATH:RPOWER:VOLTAGE:
HYSTERESIS?
-> :CHANNEL:RMATH:RPOWER:VOLTAGE:
   HYSTERESIS HIGH
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:SC<x2>

Function Sets or queries source waveforms 1 to 3 of the currently specified real time math operation.

Syntax
```
:CHANnel<x1>:RMATh:
SC<x2> {<NRf>[,<NRf>]|RMATh<x3>}
:CHANnel<x1>:RMATh:SC<x2>?
<x2> = 1 to 3
<x3> = 1 to 15
<NRf> = 1 to 16
```

Example
```
CHANNEL1:RMATH:SC1 1
CHANNEL1:RMATH:SC1?
-> CHANNEL1:RMATH:SC1 1
```

Description
- This command is valid on models with the /G3 option.
- Use the :CHANnel<x1>:RMATh:FREQ:SOURce command to set the frequency, period, and edge count operations.
- To set the target of the electrical angle operation, use this command with parameter <x> set to 3.

:CHANnel<x>:RMATh:SC4

Function Sets or queries source waveform 4 for the polynomial with a coefficient operation of the specified real time math channel.

Syntax
```
:CHANnel<x>:RMATh:
SC4 {Off|<NRf>[,<NRf>]|RMATh<x3>}
:CHANnel<x>:RMATh:SC4?
<x3> = 1 to 15
<NRf> = 1 to 16
```

Example
```
CHANNEL1:RMATH:SC4 1
CHANNEL1:RMATH:SC4?
-> CHANNEL1:RMATH:SC4 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:SCALe

Function Sets or queries the two ends of the scale of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:SCALe {<NRf>,
<NRf>}
:CHANnel<x>:RMATh:SCALe?
<x> = 1 to 16
<NRf> = -9.9999E+30 to +9.9999E+30
```

Example
```
:CHANNEL1:RMATH:
SCALE -1.0000E+10,+1.0000E+10
:CHANNEL1:RMATH:SCALE?
-> :CHANNEL1:RMATH:
   SCALE {-1.0000E+10,+1.0000E+10}
```

Description This command is valid on models with the /G3 option.

:CHANnel<x1>:RMATh:SQRT1:SIGN

Function Sets or queries the sign for the specified channel's square root operation.

Syntax
```
:CHANnel<x>:RMATh:SQRT1:
SIGN {MINus|PLUS}
:CHANnel<x>:RMATh:SQRT1:SIGN?
<x1> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:SQRT1:SIGN1 PLUS
:CHANNEL1:RMATH:SQRT1:SIGN1?
-> :CHANNEL1:RMATH:SQRT1:SIGN1 PLUS
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:UNIT

Function Sets or queries the unit string of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:UNIT {<String>}
:CHANnel<x>:RMATh:UNIT?
<x> = 1 to 16
<String> = Up to 4 characters
```

Example
```
:CHANNEL1:RMATH:UNIT" RPM"
:CHANNEL1:RMATH:UNIT?
-> :CHANNEL1:RMATH:UNIT" RPM"
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:VARiable

Function Sets or queries the vertical scale setup method of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:
VARiable {<Boolean>}
:CHANnel<x>:RMATh:VARiable?
<x> = 1 to 16
```

Example
```
:CHANNEL1:RMATH:VARIABLE 1
:CHANNEL1:RMATH:VARIABLE?
-> :CHANNEL1:RMATH:VARIABLE 1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:VDIV

Function Sets or queries the value/div setting of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:VDIV {<NRf>}
:CHANnel<x>:RMATh:VDIV?
<x> = 1 to 16
<NRf> = 1e-20 to 5e20
```

Example
```
:CHANNEL1:RMATH:VDIV 1E1
:CHANNEL1:RMATH:VDIV?
-> :CHANNEL1:RMATH:VDIV 1E1
```

Description This command is valid on models with the /G3 option.

:CHANnel<x>:RMATh:ZOOM

Function Sets or queries the vertical zoom factor of the specified RMath channel (the specified channel when real time math is turned on).

Syntax
```
:CHANnel<x>:RMATh:ZOOM {<NRf>}
:CHANnel<x>:RMATh:ZOOM?
<x> = 1 to 16
<NRf> = 0.1, 0.111, 0.125, 0.143,
        0.167, 0.2, 0.25, 0.33, 0.4,
        0.5, 0.556, 0.625,0.667,
        0.714, 0.8, 0.833, 1, 1.11,
        1.25, 1.33, 1.43, 1.67, 2,
        2.22, 2.5, 3.33, 4, 5,6.67,
        8, 10, 12.5, 16.7, 20, 25,
        40, 50, 100
```

Example
```
:CHANNEL1:RMATH:ZOOM 5
:CHANNEL1:RMATH:ZOOM?
-> :CHANNEL1:RMATH:ZOOM 5
```

Description This command is valid on models with the /G3 option.

5 Error Messages

Messages

Messages may appear on the screen during operation. This section describes the error messages and how to respond to them. You can display the messages in the language that you specify through the operations explained section 18.5 in user's manual, IM DL850-02EN.

Execution Errors

Code	Message	Page
722	Cannot execute search because RealTime math mode is changed after acquisition.	—

Setup Errors

Code	Message	Page
886	Cannot set RealTime Math mode to ON due to the following problems. -The slot is installed 720220, 720221, 720240 or 720241. -There are not any input which can be set to source for RealTime Math.	1-23
887	There are not any modules which can be set to source for this operation.	1-23
888	Cannot set RealTime Math mode to ON while RealTime Math Function is disable.	3-3

Appendix Digital Filter and Real Time Math

Digital Filter Operation Type

The DL850/DL850V has the following two digital filter operation types.

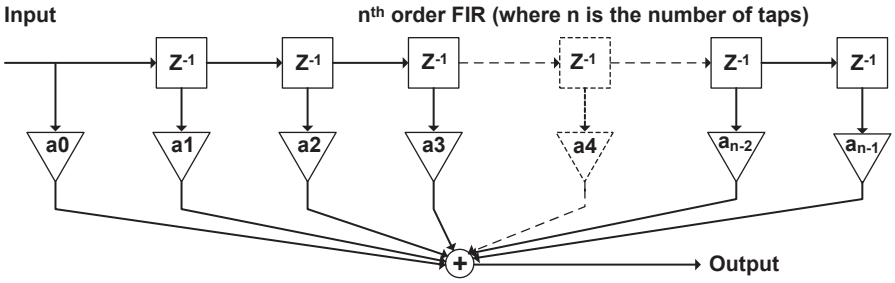
- FIR
- IIR

FIR

The signal block diagram for math that uses an FIR digital filter is shown below. The FIR filter has the following features:

1. A steep, high-order filter can be achieved within the range of the math time.
   However, as the order becomes higher, the math delay becomes longer.
2. Because the filter has linear phase characteristics, it has a constant group delay. Therefore, it has a small amount of phase distortion.
   In real time math, the following filters can be used as FIR filters:
   - Sharp
   - Gauss
   - Mean

Signal Block Diagram of an FIR Filter

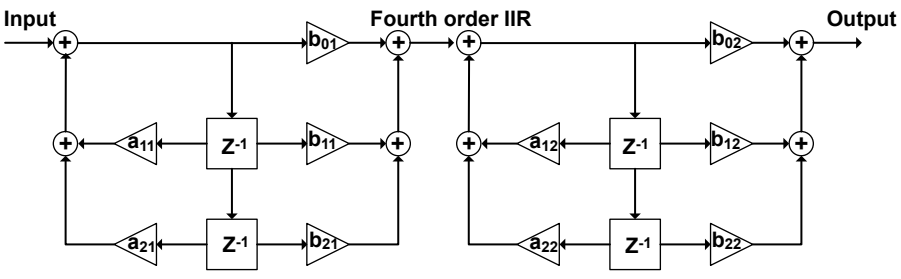


IIR

The signal block diagram for math that uses an IIR digital filter is shown below. The IIR filter has the following features:

1. Even with comparatively low orders, the filter can obtain sufficient cutoff characteristics.
   Therefore, the math delay and group delay are small compared to FIR.
2. The frequency can be set to a lower value than is possible with FIR.
3. Because it has non-linear phase characteristics, the phase distortion of an IIR filter is greater than that of an FIR filter.
   In real time math, a Butterworth filter, which has characteristics similar to an analog filter, can be used as an IIR filter.

Signal Block Diagram of an IIR Filter



Filter Features

The features of each filter are listed below.

Type	Features	Band	Operation Type
Sharp	Frequency characteristics with a sharp attenuation slope (–40 dB at 1 oct) Linear phase and constant group delay Ripples present in the passband Comb-shaped stopband	Low-Pass High-Pass Band-Pass	FIR
Gauss	Frequency characteristics with a smooth attenuation slope Linear phase and constant group delay No ripples present in the passband No overshoot in the step response Low order and short delay	Low-Pass	FIR
Mean	Comb-shaped frequency characteristics Linear phase and constant group delay No overshoot in the step response	Low-Pass	FIR
IIR (Butterworth)	Attenuation slope steepness between those of the Sharp and Gauss filters Non-linear phase and non-constant group delay No ripples present in the passband and stopband Compared to Sharp and Gauss filters, low cutoff frequency possible Characteristics similar to those of analog filters	Low-Pass High-Pass Band-Pass	IIR

Type	Passband Ripple	Attenuation Slope	Stopband Attenuation	Phase	Selectable Cutoff Range
Sharp	0 dB	–40 dB at 1 oct (Low-Pass)			
		–40 dB at –1 oct (High-Pass)	–40 dB	Linear phase	2 to 30% of the calculation frequency
Gauss	±0.3 dB	$-3.0 \times (f/fc)^2$ dB		Linear phase	2 to 30% of the calculation frequency
Mean	0 dB	See the characteristics graph		Linear phase	—
IIR (Butterworth)	0 dB	–24 dB at 1 oct (Low-Pass)			
		–24 dB at –1 oct (High-Pass)		Non-linear phase	0.2 to 30% of the calculation frequency

About the Group Delay Characteristic

In the filter response characteristics, the delay (in seconds) between the input frequency (sine wave) and the output frequency is known as group delay. The group delay can be normalized by the calculation period (Ts). Group delay is expressed in units of s/Ts. The length of the group delay for each frequency can be determined by the following equation: “group delay of the frequency × calculation period.”

Example

The length of the group delay for the mean can be calculated as shown below (the group delay is constant, regardless of the frequency).

Group delay (in s/Ts) when the mean filter is used = (number of mean points – 1)/2

If there are 16 mean points,

Group delay (in s/Ts) = (16 – 1)/2 = 15/2 = 7.5 s/Ts.

If the calculation frequency (fs) is 100 kHz,

Ts = 1/fs = 1/(100 kHz) = 10 µs.

Therefore,

Length of delay = Group delay × calculation period = 7.5 s/Ts × 10 µs = 75 µs.

About the Calculation Frequency

With the digital filter and IIR filter of real time math, the calculation frequency is automatically set internally depending on the cutoff frequency. Once per calculation period—which is determined from this calculation frequency—simple decimation is performed on the data, and the filter operation is performed, so the filter calculation results are updated once per calculation period.
The calculation frequencies are shown below.

Digital Filter

Cutoff Frequency Range	Calculation Frequency
300 kHz to 30 kHz	1 MHz
29.8 kHz to 3 kHz	100 kHz
2.98 kHz to 300 Hz	10 kHz
298 Hz to 30 Hz	1 kHz
29.8 Hz or less	100 Hz

Real Time Math IIR Filter

Cutoff Frequency Range	Calculation Frequency
3 MHz to 300 kHz	10 MHz
298 kHz to 30 kHz	1 MHz
29.8 kHz to 3 kHz	100 kHz
2.98 kHz to 300 Hz	10 kHz
298 Hz to 30 Hz	1 kHz
29.8 Hz or less	100 Hz

About the Math Delay

The math delay can be calculated from the following equation.

Math delay = 1.4 µs + digital filter delay + math time

If you are not using the digital filter and math features, the delay and math time both become 0.
The digital filter delay varies depending on the filter type and the calculation frequency. For details on the delay, see each filter's math delay explanation.
The math time is different for each function. A table of the math times for each function is shown below.

Function	Math Time (µs)	Notes
S1+S2	0.0	
S1–S2	0.0	
S1*S2	0.0	
S1/S2	0.0	
A(S1)+B(S2)+C	0.0	
A(S1)–B(S2)+C	0.0	
A(S1)*B(S2)+C	0.0	
A(S1)/B(S2)+C	0.0	
Diff	See the filter explanations.	
Integ1	0.2	
Integ2	0.2	
Angle	0.2	
DA	0.2	
Polynomial	0.8	The data is updated once per microsecond.
RMS	0.6	The data is updated once per the specified period.
Power	0.4	The data is updated once per the specified period.
Power Integ	0.2	
Log1	0.4	
Log2	0.2	
Sqrt1	0.2	
Sqrt2	0.0	
Cos	0.2	
Sin	0.2	
Atan	0.3	
Electric Angle	1.1	The data is updated once per the specified period.
Knocking Filter	0.0	
Poly-Add-Sub	0.0	
Frequency	0.2	The data is updated each time that an edge is detected.
Period	0.2	The data is updated each time that an edge is detected.
Edge Count	0.2	The data is updated each time that an edge is detected.
Resolver	0.4	The data is updated once per excitation voltage period.
IIR Filter	See the filter explanations.	
PWM	0.2	
Reactive Power	0.2	
CAN ID	The calculation period is from the last bit sample point of the CAN frame ID to the point of detection. The sample point is approximately at the 70% point of the time span of a bit.	

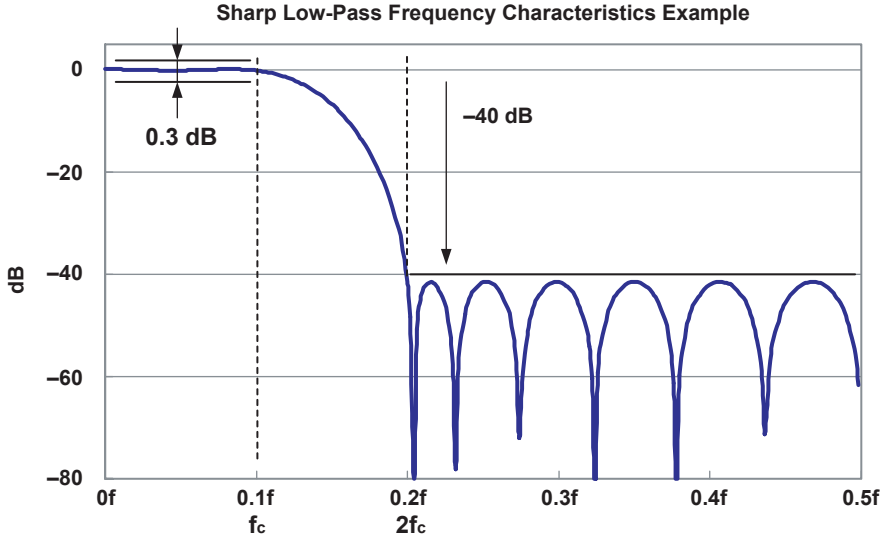
Sharp Filter

Characteristics

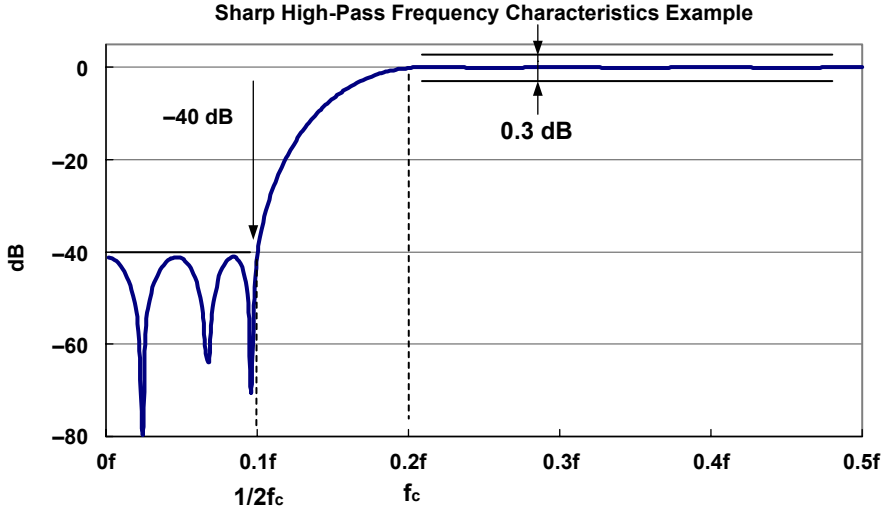
Low-Pass and High-Pass

- The ripple that is present in the passband is within 0.3 dB.
- When the frequency is equal to the cutoff frequency times 2 for low-pass or the cutoff frequency times 0.5 for high-pass, the attenuation is set to –40 dB.
- The stopband attenuation is –40 dB or greater.
- The filter has linear phase and constant group delay.

Sharp Low-Pass Frequency Characteristics Example



Sharp High-Pass Frequency Characteristics Example

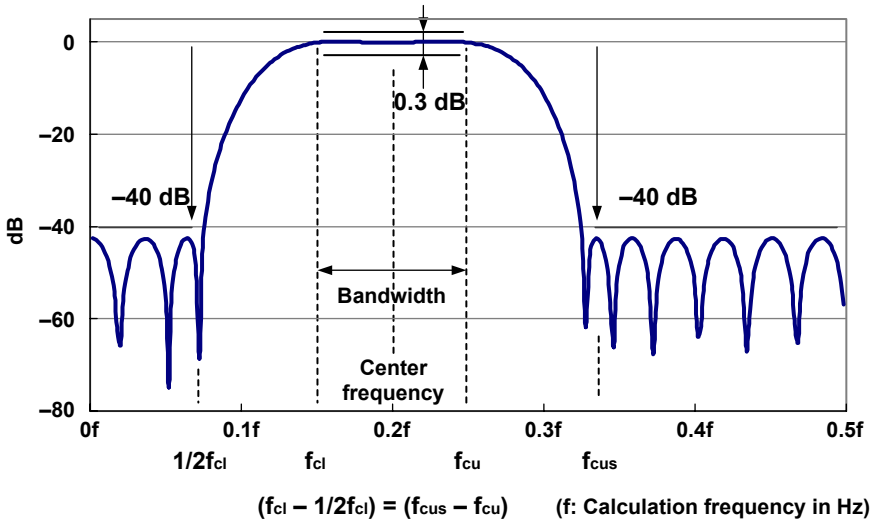


(f: Calculation frequency in Hz)

Band-Pass

- The ripple that is present in the passband is within 0.3 dB.
- In the low frequency band, when the frequency becomes half the frequency that was present at edge fcl of the passband, the attenuation is set to –40 dB.
- In the high frequency band, the width of the transition area, in which the frequency is attenuated –40 dB from the passband edge, is approximately the same as the width of the transition area in the low frequency band.
  (fcl – 1/2fcl = fcus – fcu)
- The stopband attenuation is –40 dB or greater.
- The filter has linear phase and constant group delay.

Sharp Band-Pass Frequency Characteristics Example



In the Sharp band-pass filter, the bandwidth options vary depending on the center frequency.

Sharp Band-Pass Filter Frequency Range

Center Frequency (kHz)	Bandwidth Setting (kHz)	Calculation Frequency (Hz)
300 to 120	200, 150, 100, 50, 20	1 M
118 to 96	150, 100, 50, 20	1 M
94 to 70	100, 50, 20	1 M
68 to 46	50, 20	1 M
44 to 30	20	1 M
29.8 to 12	20, 15, 10, 5, 2	100 k
11.8 to 9.6	15, 10, 5, 2	100 k
9.4 to 7	10, 5, 2	100 k
6.8 to 4.6	5, 2	100 k
4.4 to 3	2	100 k
2.98 to 1.2	2, 1.5, 1, 0.5, 0.2	10 k
1.18 to 0.96	1.5, 1, 0.5, 0.2	10 k
0.94 to 0.7	1, 0.5, 0.2	10 k
0.68 to 0.46	0.5, 0.2	10 k
0.44 to 0.3	0.2	10 k

Order Tables

The orders of each Sharp filter are listed below. The cutoff and center frequency settings are given as percentages of the calculation frequency.

Sharp Low-Pass Filter Orders

Cutoff frequency	2%	3%	4%	5%	6%	7%	8%	9%	10%
Order	94	61	46	37	32	28	24	22	20
Cutoff frequency	11%	12%	13%	14%	15%	16%	17%	18%	19%
Order	17	17	15	14	13	13	11	11	11
Cutoff frequency	20%	21%	22%	23%	24%	25%	26%	27%	28%
Order	10	11	9	9	8	8	8	8	8
Cutoff frequency	29%	30%							
Order	8	8							

Sharp High-Pass Filter Orders

Cutoff frequency	2%	3%	4%	5%	6%	7%	8%	9%	10%
Order	191	127	97	77	65	55	49	45	39
Cutoff frequency	11%	12%	13%	14%	15%	16%	17%	18%	19%
Order	37	33	31	29	27	25	25	23	23
Cutoff frequency	20%	21%	22%	23%	24%	25%	26%	27%	28%
Order	21	21	19	19	19	17	17	17	15
Cutoff frequency	29%	30%							
Order	15	15							

Sharp Band-Pass Filter Orders (Passband width: 2%)

Center frequency	3%	4%	5%	6%	7%	8%	9%	10%	11%
Order	189	142	93	80	69	61	54	49	45
Center frequency	12%	13%	14%	15%	16%	17%	18%	19%	20%
Order	41	37	34	32	27	20	18	18	17
Center frequency	21%	22%	23%	24%	25%	26%	27%	28%	29%
Order	16	16	14	14	14	13	13	12	13
Center frequency	30%								
Order	11								

Sharp Band-Pass Filter Orders (Passband width: 5%)

Center frequency	5%	6%	7%	8%	9%	10%	11%	12%	13%
Order	154	112	93	72	64	58	51	40	37
Center frequency	14%	15%	16%	17%	18%	19%	20%	21%	22%
Order	35	33	31	29	28	26	25	24	23
Center frequency	23%	24%	25%	26%	27%	28%	29%	30%	
Order	22	21	20	19	19	18	17	18	

Sharp Band-Pass Filter Orders (Passband width: 10%)

Center frequency	7%	8%	9%	10%	11%	12%	13%	14%	15%
Order	194	132	97	78	69	57	52	47	39
Center frequency	16%	17%	18%	19%	20%	21%	22%	23%	24%
Order	37	35	33	31	30	28	27	23	23
Center frequency	25%	26%	27%	28%	29%	30%			
Order	20	19	18	18	17	16			

Sharp Band-Pass Filter Orders (Passband width: 15%)

Center frequency	10%	11%	12%	13%	14%	15%	16%	17%	18%
Order	155	110	89	73	62	52	49	41	38
Center frequency	19%	20%	21%	22%	23%	24%	25%	26%	27%
Order	36	34	32	27	26	25	24	23	22
Center frequency	28%	29%	30%						
Order	21	21	21						

Sharp Band-Pass Filter Orders (Passband width: 20%)

Center frequency	12%	13%	14%	15%	16%	17%	18%	19%	20%
Order	191	129	98	78	67	58	49	46	40
Center frequency	21%	22%	23%	24%	25%	26%	27%	28%	29%
Order	38	36	31	29	28	27	26	25	24
Center frequency	30%								
Order	20								

Math Delay

The group delay can be calculated from the following equation. The group delay is constant based on the filter order.

Group delay = (filter order – 1)/2

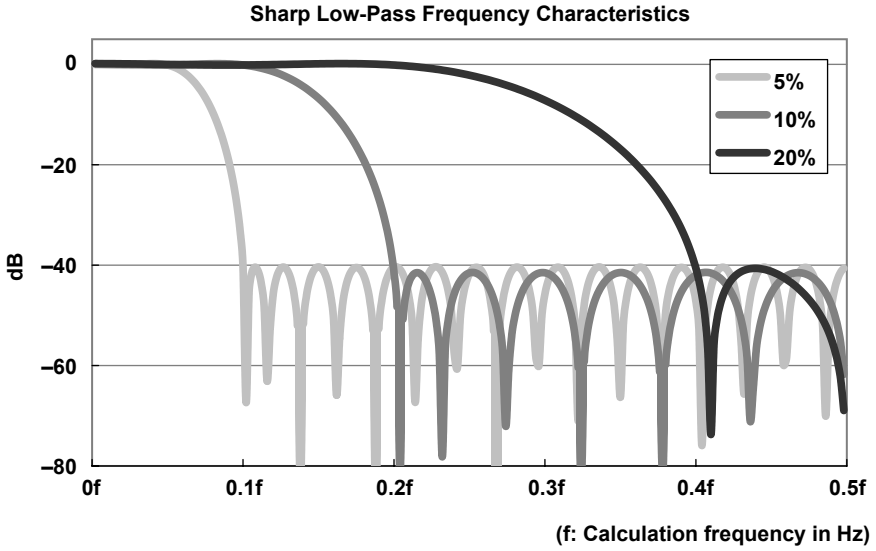
Unit: s/Ts (Ts is the calculation period in seconds)

The math delay can be calculated from the following equation.

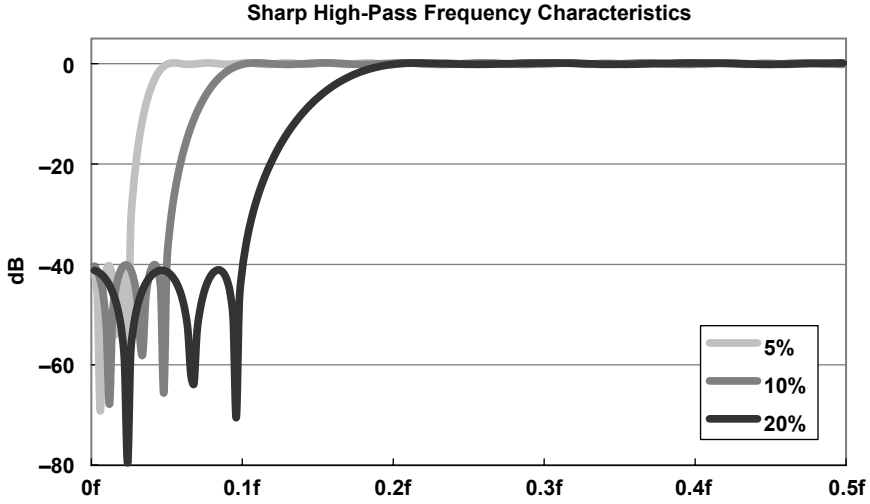
Math delay = 1.4 µs + {(filter order – 1)/2} × calculation period

Examples of Characteristics

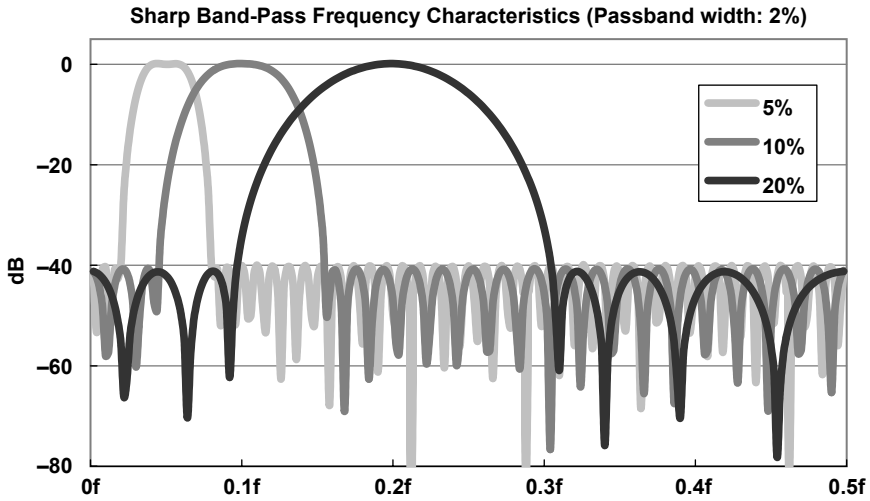
Sharp Low-Pass



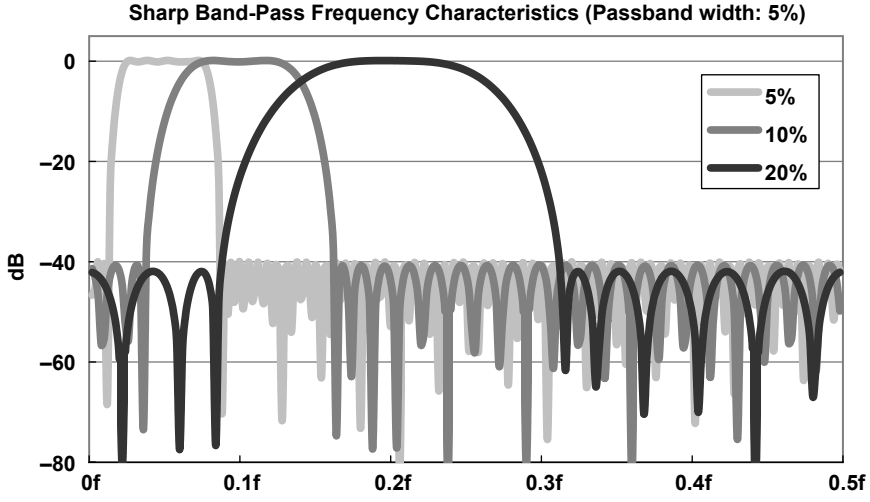
Sharp High-Pass



Sharp Band-Pass (Passband width: 2%)

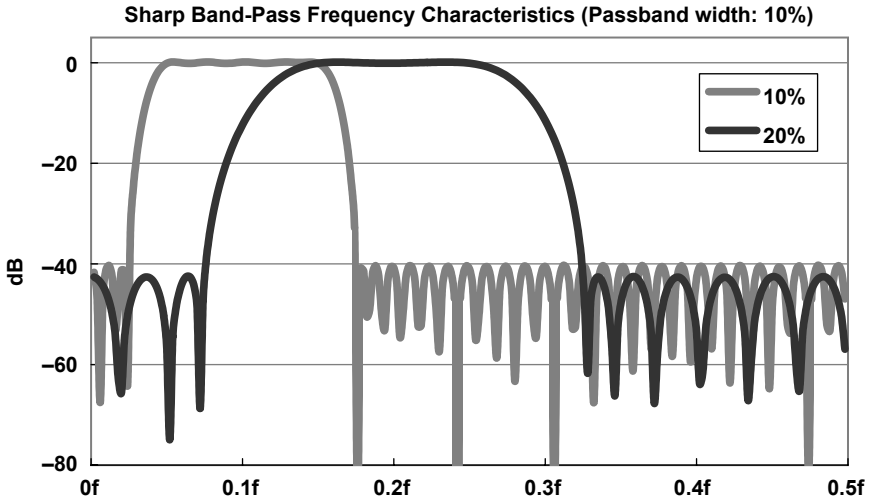


Sharp Band-Pass (Passband width: 5%)

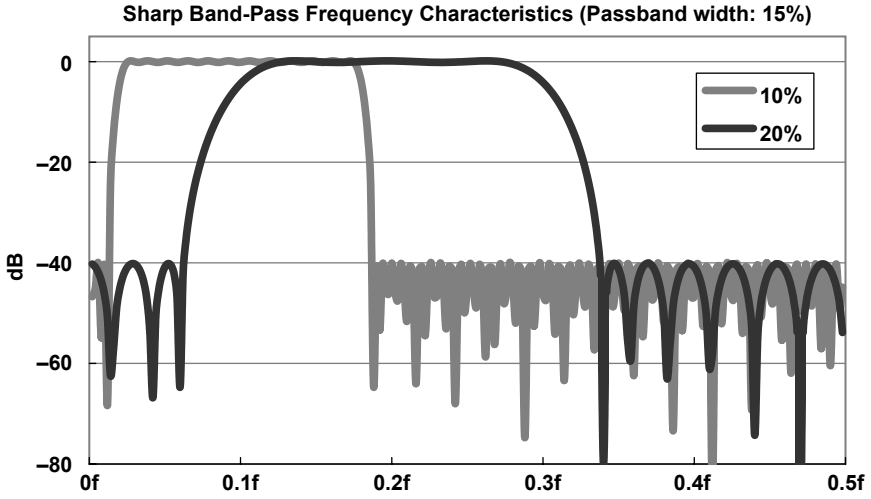


(f: Calculation frequency in Hz)

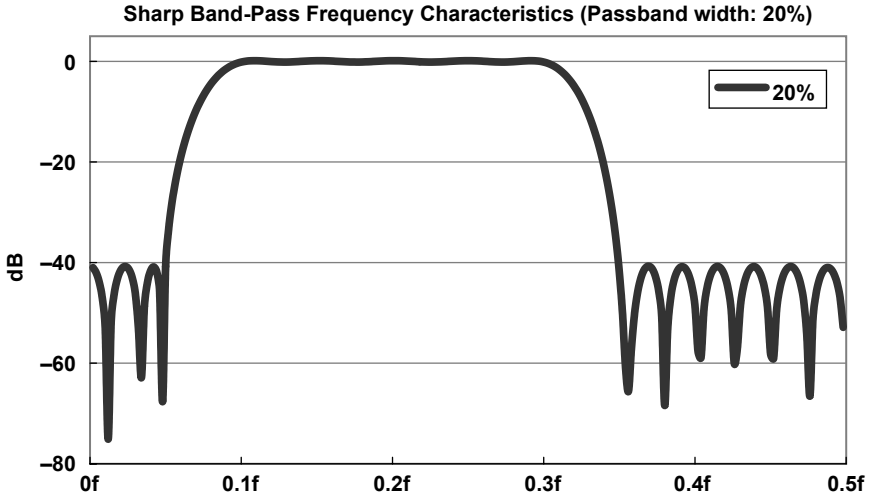
Sharp Band-Pass (Passband width: 10%)



Sharp Band-Pass (Passband width: 15%)



Sharp Band-Pass (Passband width: 20%)



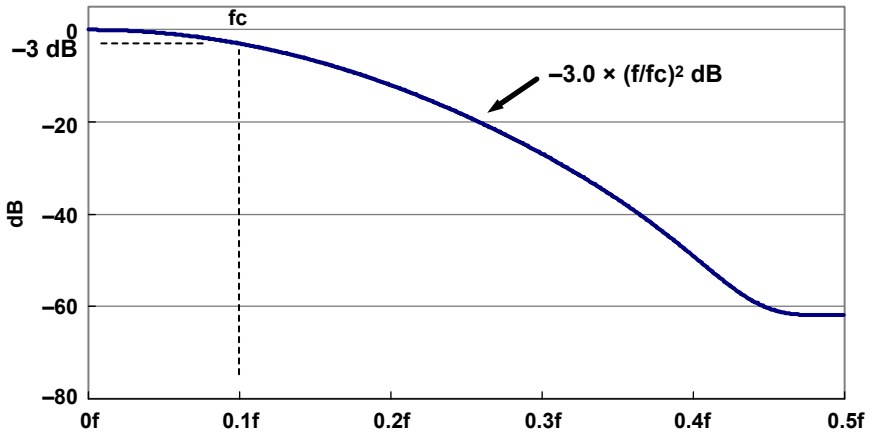
(f: Calculation frequency in Hz)

Gauss Filter

Characteristics

- The passband is flat.
- At the cutoff frequency, the attenuation is –3 dB.
  The damping rate is $–3.0 \times (f/fc)^2$.
- The filter has linear phase and constant group delay.
- The filter can only be set to low-pass.

Gauss Frequency Characteristics Example



(f: Calculation frequency in Hz)

Order Table

The orders of the Gauss filter are shown below. The cutoff frequency settings are given as percentages of the calculation frequency.

Gauss Filter Orders

Cutoff frequency	2%	3%	4%	5%	6%	7%	8%	9%	10%
Order	49	33	25	21	17	17	13	13	9
Cutoff frequency	11%	12%	13%	14%	15%	16%	17%	18%	19%
Order	9	9	9	9	9	9	5	5	5
Cutoff frequency	20%	21%	22%	23%	24%	25%	26%	27%	28%
Order	5	5	5	5	5	5	5	5	5
Cutoff frequency	29%	30%							
Order	5	5							

Math Delay

The group delay can be calculated from the following equation. The group delay is constant based on the filter order.

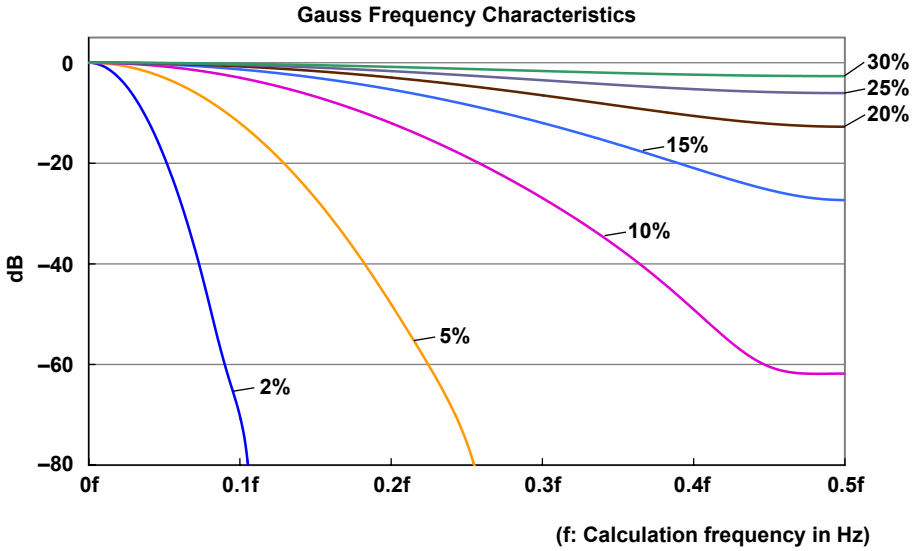
Group delay = (filter order – 1)/2

Unit: s/Ts (Ts is the calculation period in seconds)

The math delay can be calculated from the following equation.

Math delay = 1.4 µs + {(filter order – 1)/2} × calculation period

Example of Characteristics



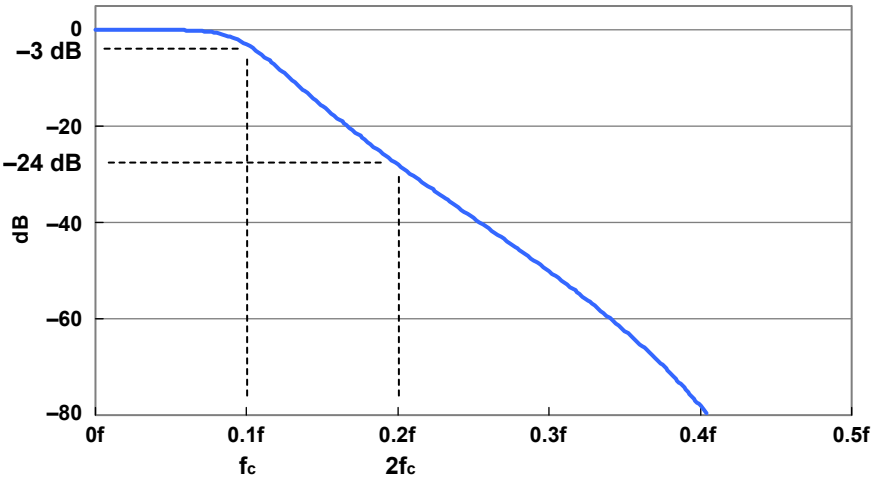
IIR (Butterworth)

Characteristics

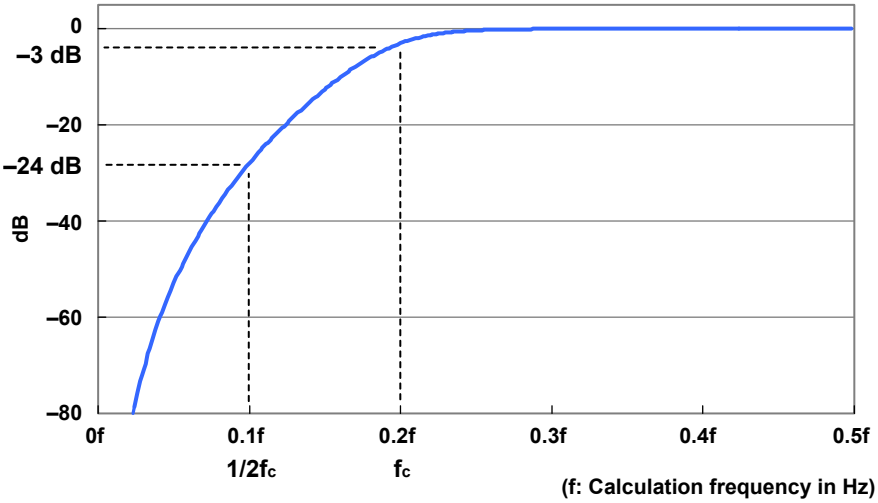
Low-Pass and High-Pass

- This is a fourth order Butterworth filter. The damping rate is approximately –24 dB/oct.
- The passband is flat.
- At the cutoff frequency, the attenuation is –3 dB.
- It has non-linear phase characteristics.
- You can set the frequency lower than other FIR filters.

IIR (Butterworth) Low-Pass Frequency Characteristics Example



IIR (Butterworth) High-Pass Frequency Characteristics Example

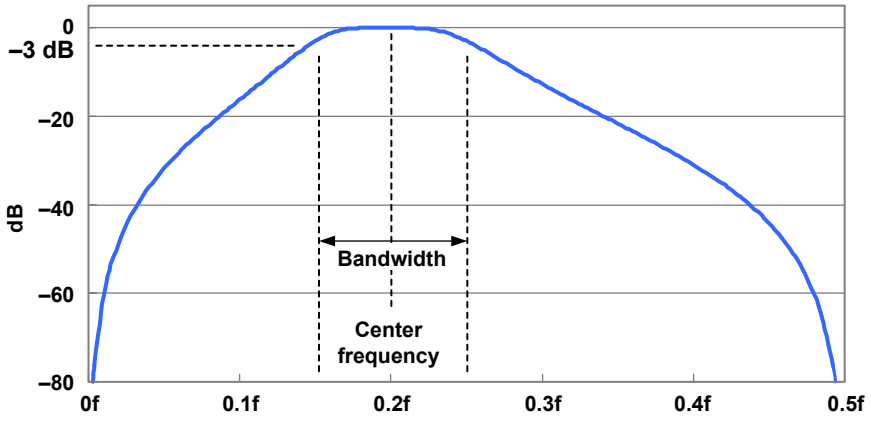


(f: Calculation frequency in Hz)

Band-Pass

- The passband is flat.
- At each end of the passband, the attenuation is –3 dB.
- This is a fourth order Butterworth filter. There are no ripples present in the stopband. For the cutoff characteristic, see “Examples of Characteristics” later in this section.
- It has non-linear phase characteristics.
- You can set the frequency lower than the Sharp filter.

IIR (Butterworth) Band-Pass Frequency Characteristics Example



(f: Calculation frequency in Hz)

In the IIR (Butterworth) band-pass filter, the bandwidth options vary depending on the center frequency.

IIR (Butterworth) Band-Pass Filter Frequency Ranges

Center Frequency (kHz)	Bandwidth Setting (kHz)	Calculation Frequency (Hz)
300 to 102	200, 150, 100, 50, 20, 10	1 M
100 to 76	150, 100, 50, 20, 10	1 M
74 to 52	100, 50, 20, 10	1 M
50 to 26	50, 20, 10	1 M
24 to 12	20, 10	1 M
11.8 to 10.2	20, 15, 10, 5, 2, 1	100 k
10 to 7.6	15, 10, 5, 2, 1	100 k
7.4 to 5.2	10, 5, 2, 1	100 k
5 to 2.6	5, 2, 1	100k
2.4 to 1.2	2, 1	100 k
1.18 to 1.02	2, 1.5, 1, 0.5, 0.2, 0.1	10 k
1 to 0.76	1.5, 1, 0.5, 0.2, 0.1	10 k
0.74 to 0.52	1, 0.5, 0.2, 0.1	10 k
0.5 to 0.26	0.5, 0.2, 0.1	10 k
0.24 to 0.12	0.2, 0.1	10 k
0.1 to 0.06	0.1	10 k

Math Delay

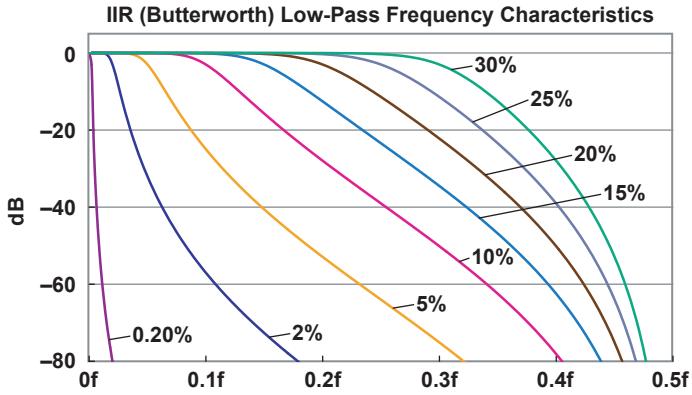
With IIR filters, unlike FIR filters, you cannot define the math delay. This is because the delay varies depending on the input frequency because of the non-linear phase characteristics of IIR filters. The group delay characteristic indicates the relationship between the frequency of the input signal and the math delay. The math delay can be calculated by adding 1.4 us to the group delay characteristic.

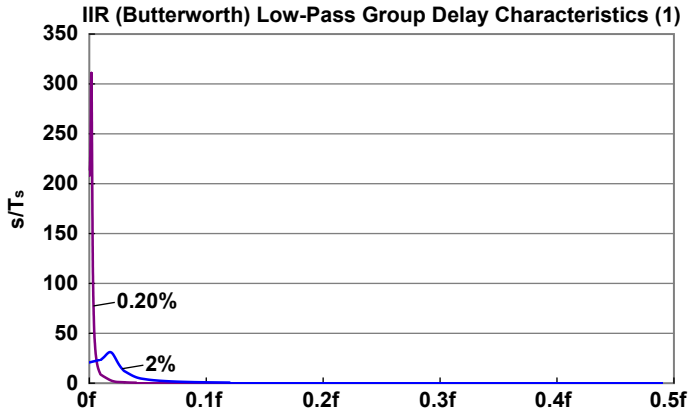
The math delay can be calculated from the following equation.

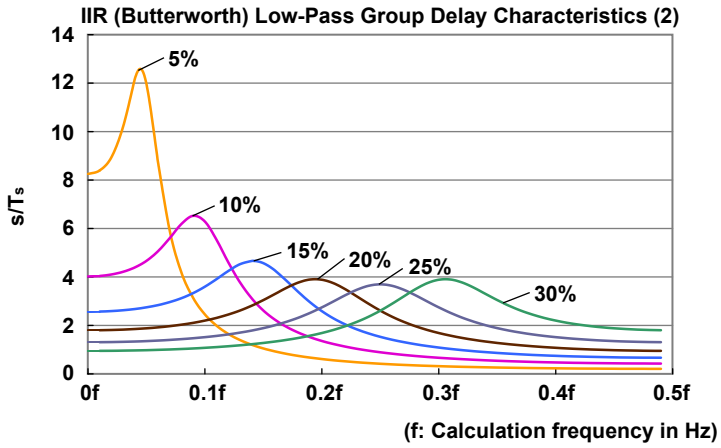
Math delay = (1.4 µs + group delay) × calculation period

Examples of Characteristics

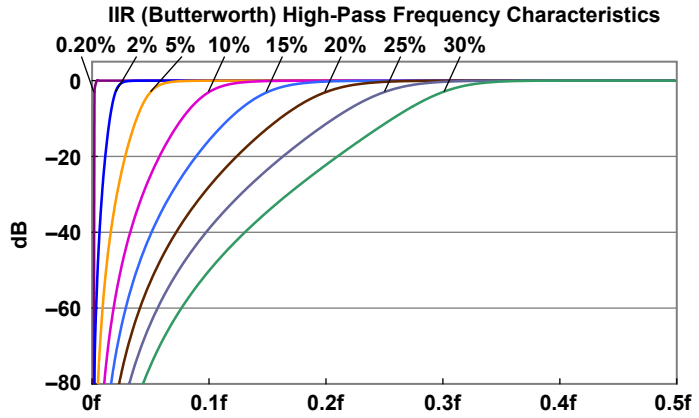
IIR (Butterworth) Low-Pass

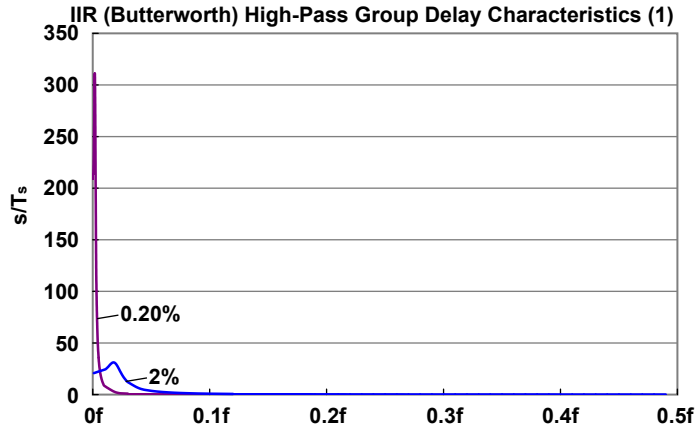


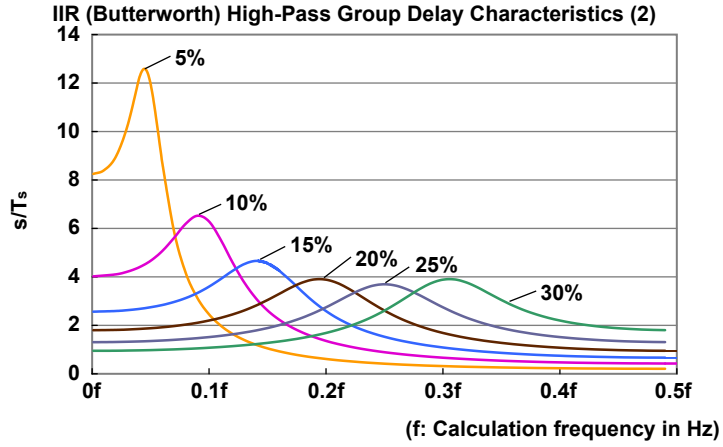




IIR (Butterworth) High-Pass

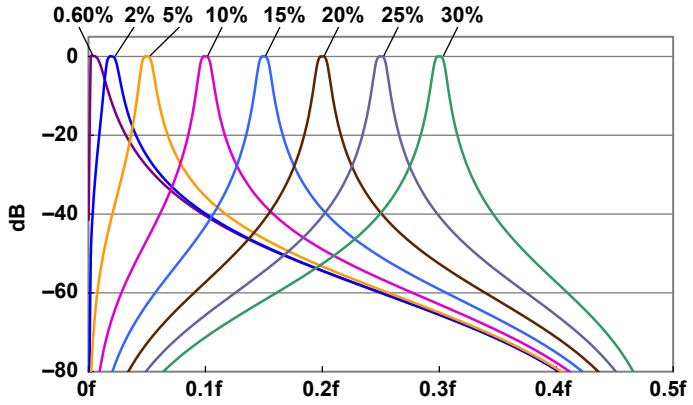




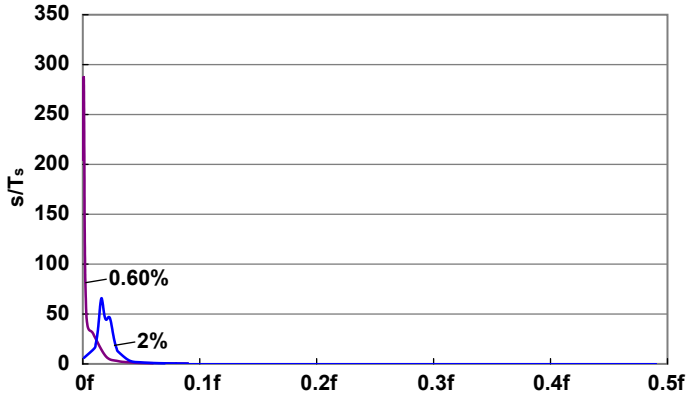


IIR (Butterworth) Band-Pass (Passband width: 1%)

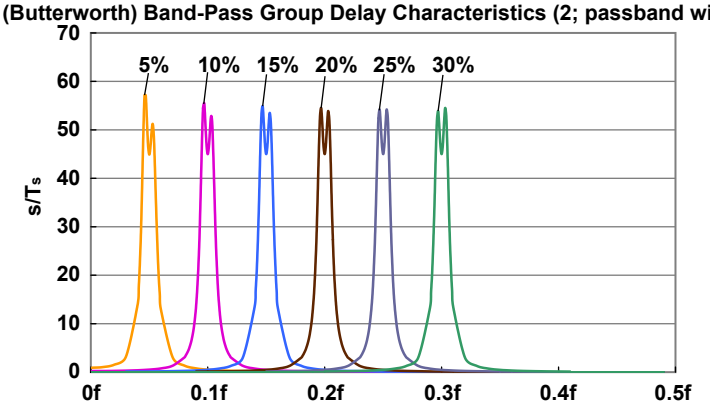
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 1%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 1%)



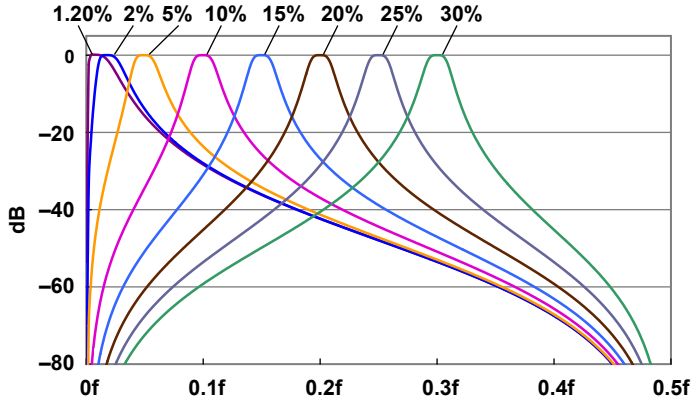
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 1%)



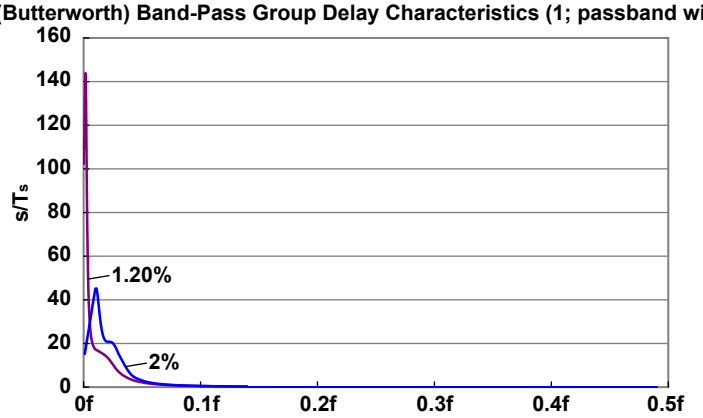
(f: Calculation frequency in Hz)

IIR (Butterworth) Band-Pass (Passband width: 2%)

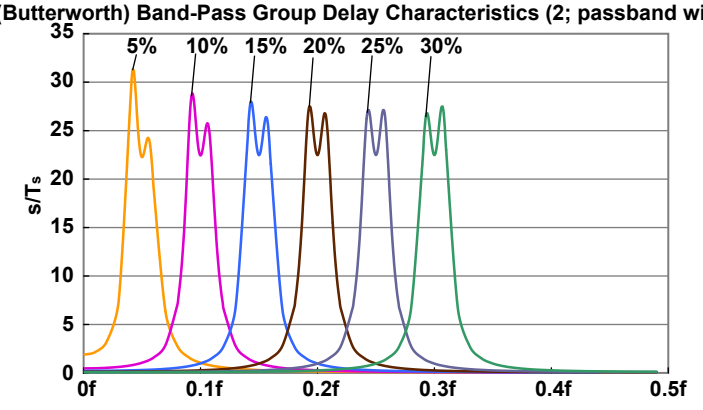
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 2%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 2%)



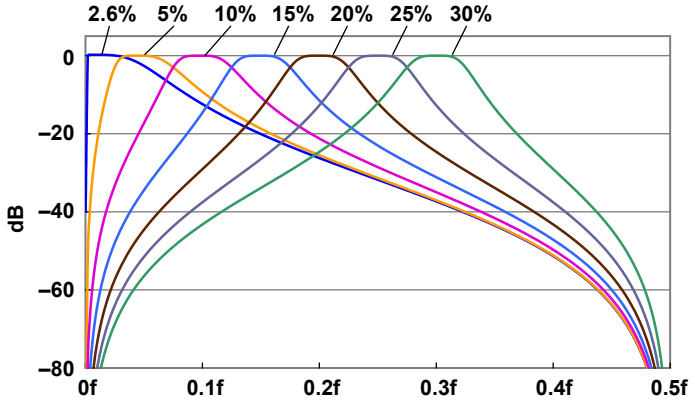
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 2%)



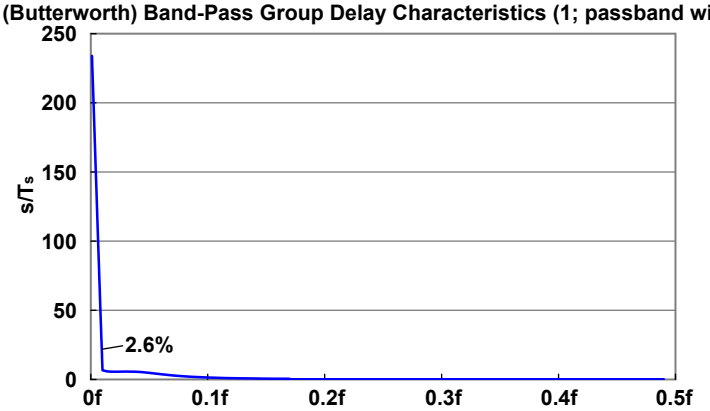
(f: Calculation frequency in Hz)

IIR (Butterworth) Band-Pass (Passband width: 5%)

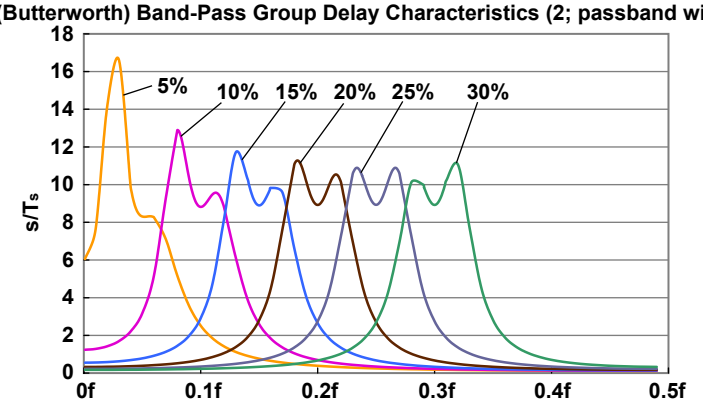
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 5%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 5%)



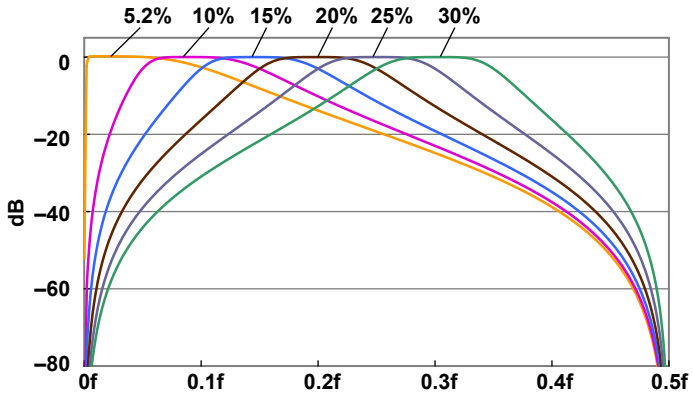
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 5%)



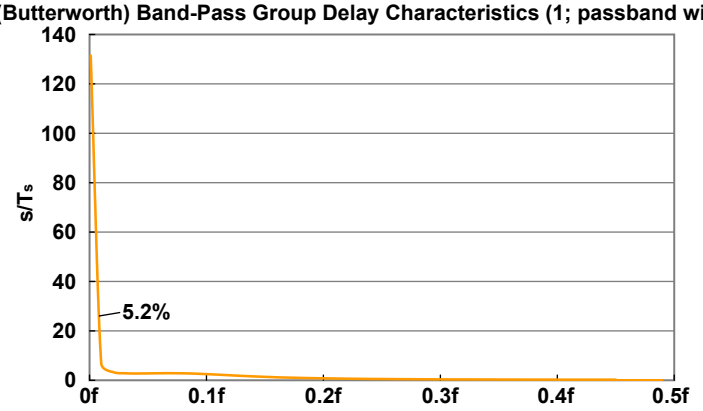
(f: Calculation frequency in Hz)

IIR (Butterworth) Band-Pass (Passband width: 10%)

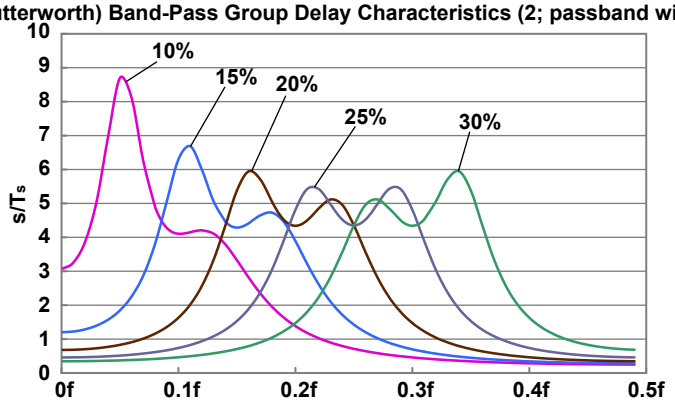
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 10%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 10%)



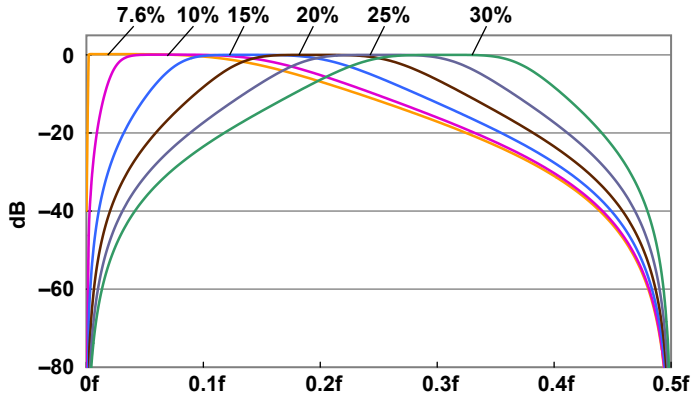
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 10%)



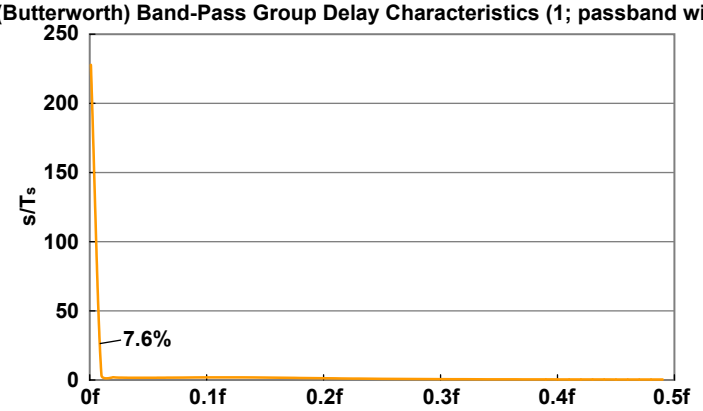
(f: Calculation frequency in Hz)

IIR (Butterworth) Band-Pass (Passband width: 15%)

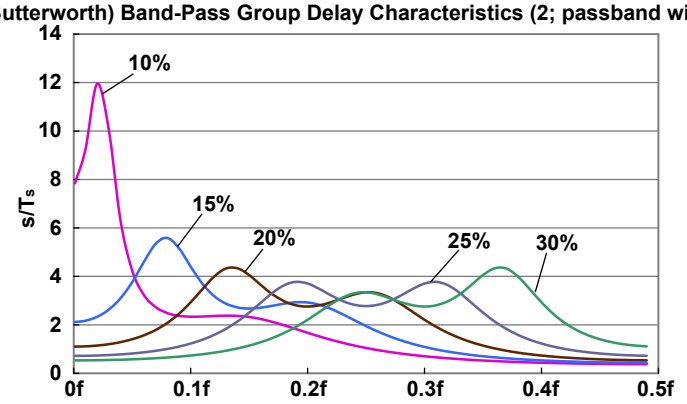
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 15%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 15%)



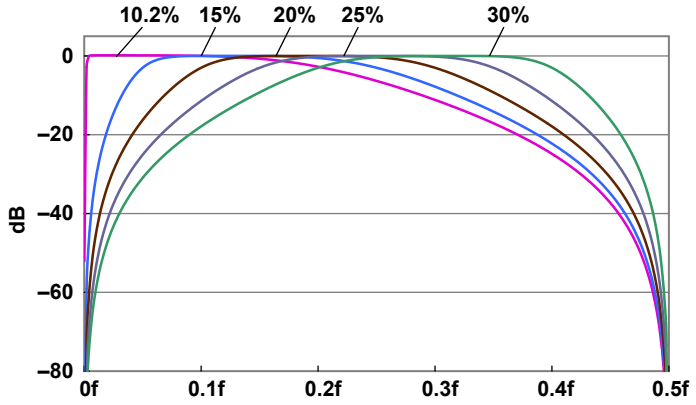
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 15%)



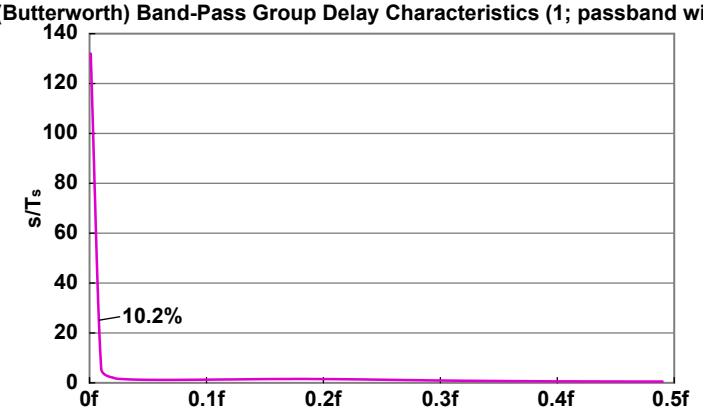
(f: Calculation frequency in Hz)

IIR (Butterworth) Band-Pass (Passband width: 20%)

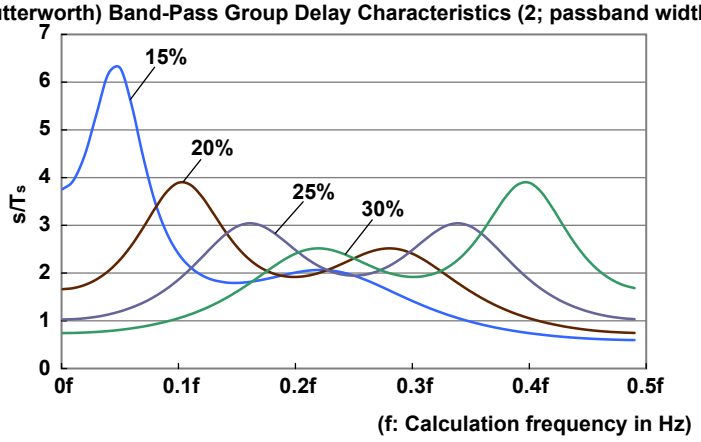
IIR (Butterworth) Band-Pass Frequency Characteristics (Passband width: 20%)



IIR (Butterworth) Band-Pass Group Delay Characteristics (1; passband width: 20%)



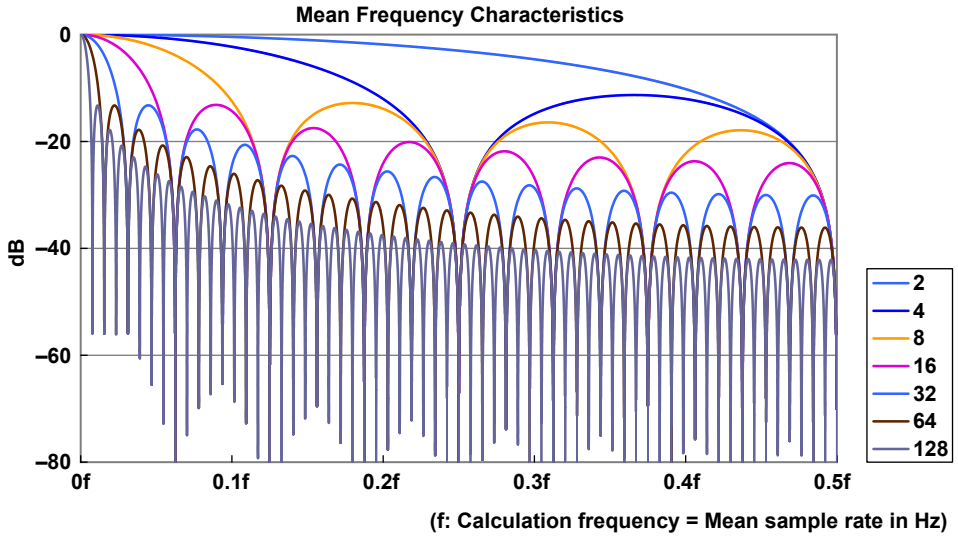
IIR (Butterworth) Band-Pass Group Delay Characteristics (2; passband width: 20%)



Mean Filter

Characteristics

- The passband is flat.
- The filter has linear phase and constant group delay.
- The characteristics are those of a low-pass filter.
- The filter has comb-shaped bandwidth characteristics.



(f: Calculation frequency = Mean sample rate in Hz)

Math Delay

The group delay can be calculated from the following equation. The group delay is constant based on the filter order.

Group delay = (number of mean points – 1)/2

Unit: s/Ts (Ts is the calculation period in seconds)

The math delay can be calculated from the following equation.

Math delay = 1.4 µs + {(number of mean points – 1)/2} × calculation period

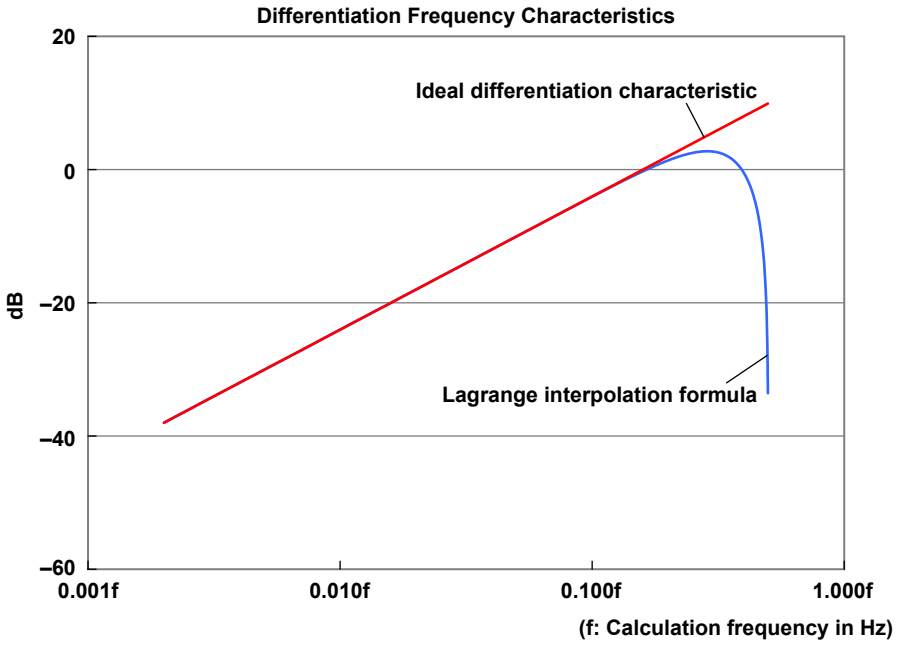
Real Time Math Differentiation

Differentiation Characteristics

The real time math differentiation operation uses a fifth order Lagrange interpolation formula to calculate the differentiated value. The fifth order Lagrange interpolation formula is shown below (see page 5 in the appendix of the Features Guide, IM DL850-01EN).

$$fn' = 1/(12Ts)\{fn-4 - 8fn-3 + 8fn-1 - fn\}$$

The following chart shows the amplitude characteristic in the case where the fifth order Lagrange interpolation formula is used and the ideal differentiation characteristic.



Up to the point where the input frequency is 20% of the calculation period, the differentiation characteristic is almost the same as the ideal differentiation characteristic. At higher frequencies, the high frequency components are restrained by the high-area characteristics of the Lagrange interpolation formula.

Math Delay

The math delay is calculated using the following formula.

Math delay = 1.4 µs + 2 × calculation period*

* The “2” in the above formula is the delay due to the Lagrange interpolation formula.

About the Calculation Frequency

Differentiation is calculated at the DL850/DL850V sampling frequency. In dual capture mode, it is calculated at the main waveform’s frequency.

However, the upper calculation frequency limit is 10 MHz. If the smaller sample rate exceeds this value, the calculation frequency is set to 10 MHz.

When you are performing external sampling, the calculation frequency is fixed to 10 MHz.

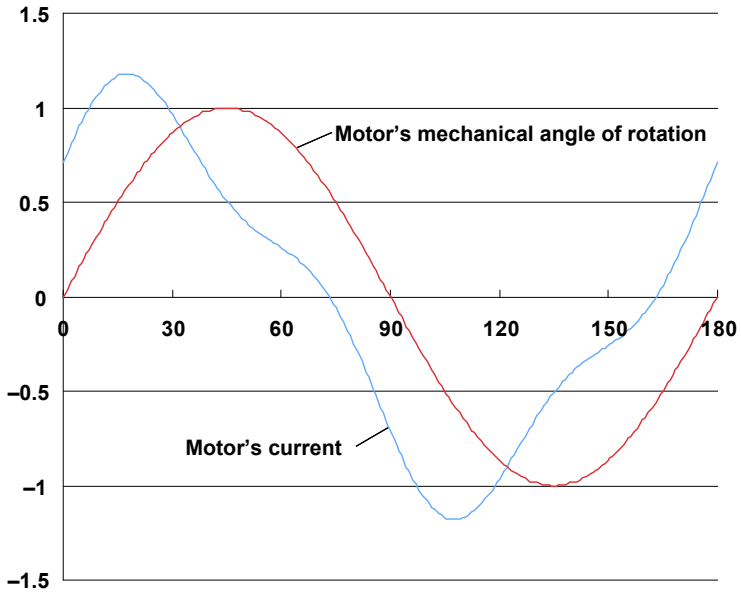
About the Electrical Angle

By using the electrical angle math operation, you can calculate the phase difference between the motor's input current and the motor's angle of rotation.

By using an encoder, you can accurately measure the motor's mechanical angle of rotation, but the current waveform using this method is distorted because harmonic components are overlaid on top of it.

In situations such as this, the phase difference between the motor's mechanical angle of rotation and its current cannot be determined in a simple manner.

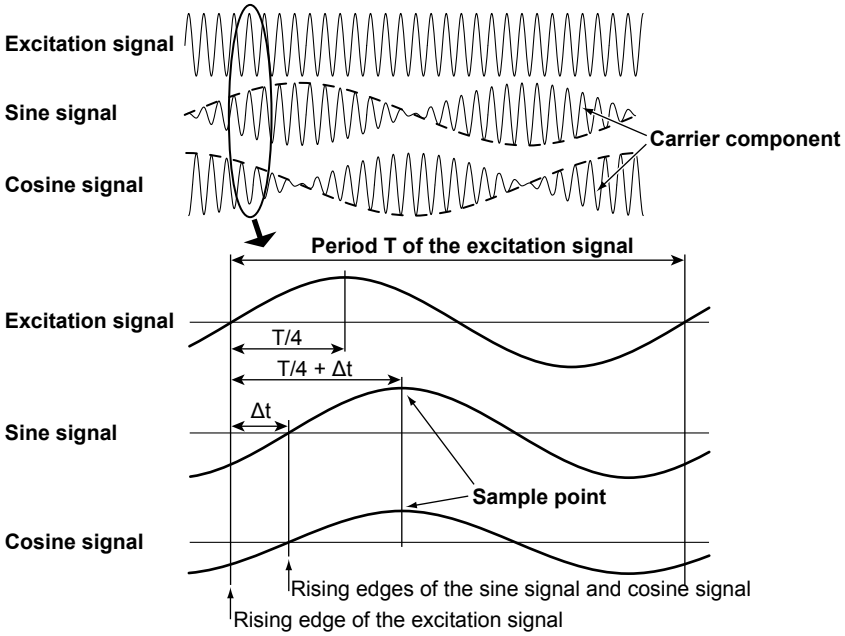
The real time math feature uses a discrete Fourier transform to determine the fundamental component of the current waveform, and then calculates the phase difference between this fundamental component and the motor's mechanical angle of rotation.



The phase difference is calculated with the motor's mechanical angle of rotation as the reference. If the phase is leading the motor's mechanical angle of rotation, the phase is displayed as a positive value.

Resolver

The angle of rotation is calculated from the excitation signal applied to the resolver and the sine signal and cosine signal that are generated from the detection coils of the resolver. To calculate the angle of rotation precisely, the data of the largest points (the peak values) of the carrier component of the sine and cosine signals are sampled, and the calculation is performed.



When the Sample Mode Is Set to Auto

The rising edge of the excitation signal is detected, and period T of the excitation signal is measured. The rising edges of the sine and cosine signals are also detected, and the time difference Δt between these rising edges and the rising edge of the excitation signal is measured. From period T and time difference Δt, the data at point T/4 + Δt is sampled.

- The Auto setting can be applied when the time difference Δt of the sine and cosine signals in reference to the excitation signal is less than ±90°(T/4).
- Turn the SCALE knob to set the vertical scale (V/div) so that the amplitudes of the excitation, sine, and cosine signals are all ±1.5 div or greater. If the amplitudes are less than ±1.5 div, the Auto function will not operate.

When the Sample Mode Is Set to Manual

The rising edge of the excitation signal is detected, and the data at the point at the specified time after this detected rising edge is sampled.

Tracking Filter

Because the resolver generates discrete signals, the calculation results are also discrete. The DL850/DL850V can use a tracking filter to convert the results into a smooth, continuous wave. The tracking filter has a low pass filter. If you set a high cutoff frequency, you can measure a signal that has faster rotations and a higher angular acceleration (change in the number of rotations). On the other hand, the stability and angle resolution in measurements during constant velocity rotations decrease.

The relationship between cutoff frequency and maximum measurable angular acceleration (measurement of the change in the number of rotations) is shown below.

Cutoff Frequency	Maximum Measurable Angular Acceleration
2kHz	140000rps^2
1kHz	54000rps^2
250kHz	1800rps^2
100Hz	180rps^2

When the rotation is fast, if you specify a low cutoff frequency, the DL850/DL850V may not be able to calculate the angle correctly. In this situation, set the cutoff frequency to a higher value.

Math Flowchart and Internal Math Expressions of Real Time Math

The math flowchart of real time math is shown below. The real time math I/O is 16-bit binary data (if the input is only 12 bits in length, it is converted to 16 bits).
Internally, real time math is performed on 32-bit floating point data, so I/O data is converted with 1 LSB weight.
Note that 16-bit binary output data is converted with the 1 LSB weight that is determined by value/div. The I/O data is normalized to 2400 LSB/div when displayed on the screen.

Math Input: Conversion of 16-Bit Binary Data to Floating-Point Data

Math source data is acquired into real time math, and at the same time, is converted with 1 LSB weight into floating-point format.
A (float) = A (binary) × (1 LSB weight)
B (float) = B (binary) × (1 LSB weight)

Internal Math

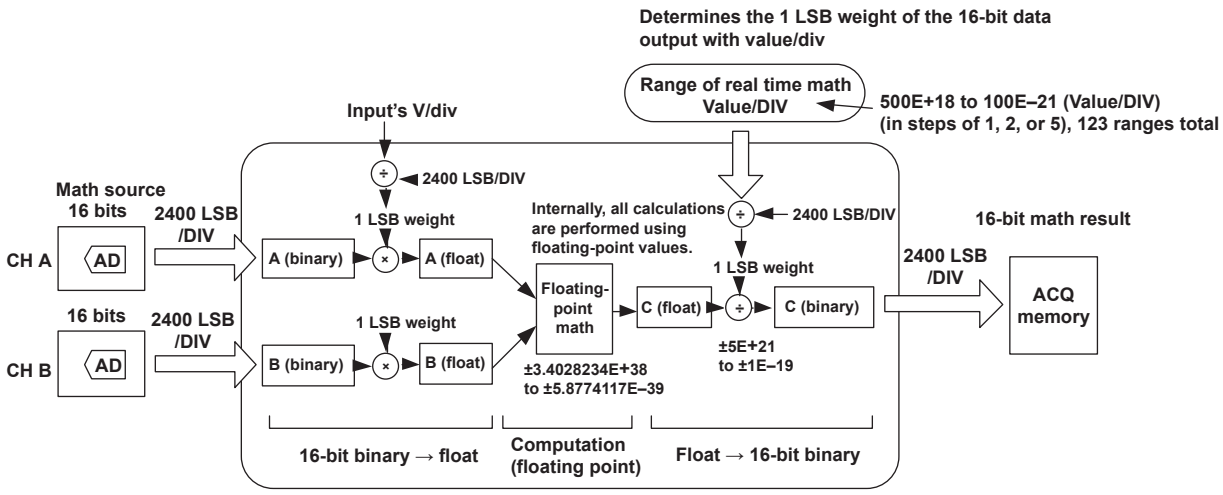
All internal real time math operations are performed using floating-point data.
Example: C (float) = A (float) + B (float)

Calculation of the 1 LSB Weight of the Output

The 1 LSB weight of the output is determined from the real time math range (value/div).
Because 1 div = 2400 LSB,
1 LSB weight of the output = (value/div)/2400.

Math Output: Conversion of Floating-Point Data to 16-Bit Binary Data

The output is converted to 16-bit data through the following formula.
C (binary) = C (float)/(1 LSB weight)



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